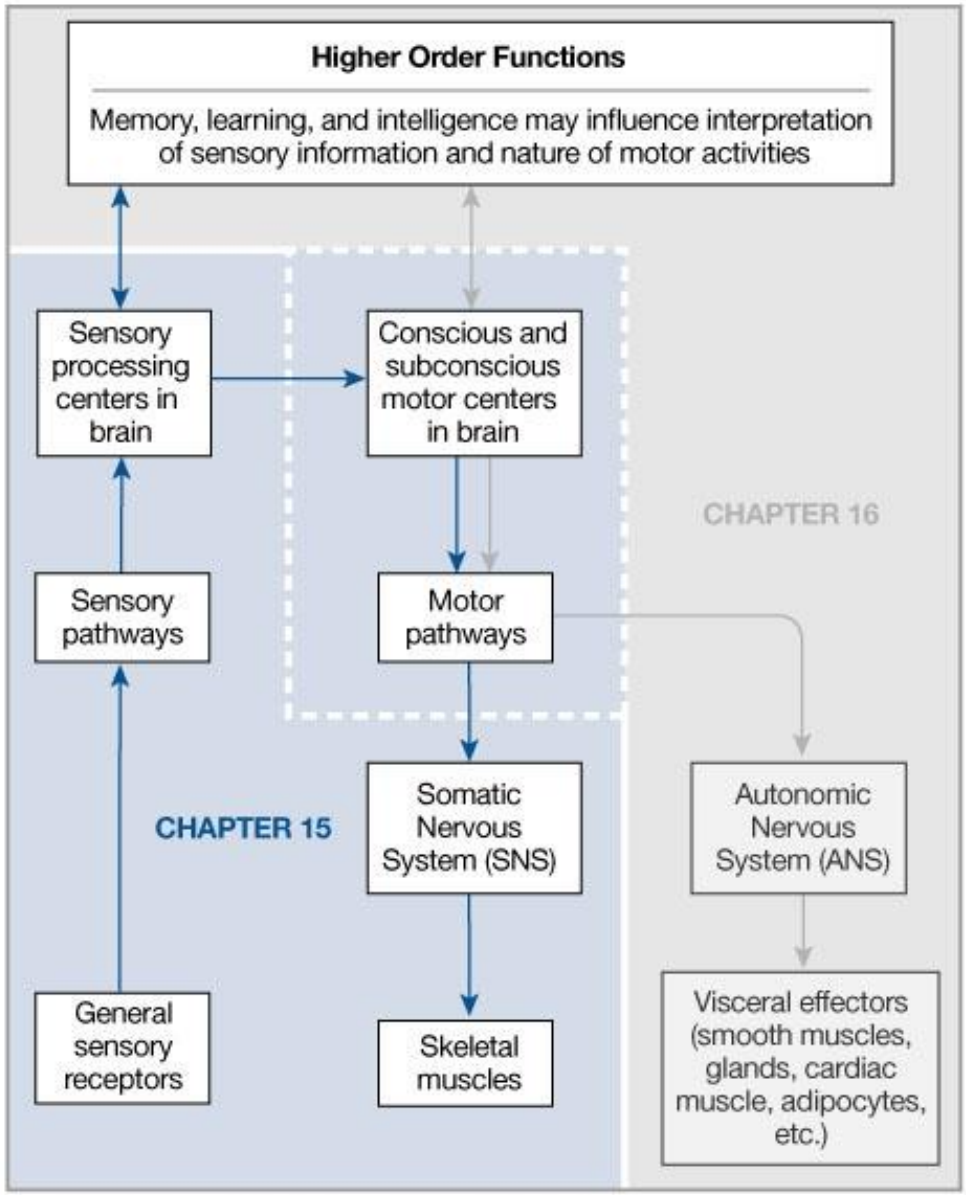
# Sensory Physiology


Higher Order Functions
Memory, learning, and intelligence may influence interpretation of sensory information and nature of motor activities
Sensory processing centers in brain
Conscious and subconscious motor centers in brain
CHAPTER 16
Sensory pathways
Motor pathways
Somatic Nervous System (SNS)
Autonomic Nervous System (ANS)
CHAPTER 15
General sensory receptors
Skeletal muscles
Visceral effectors (smooth muscles, glands, cardiac muscle, adipocytes, etc.)

# Sensory Systems

*Conscious*

**Special senses**
Vision
Hearing
Taste
Smell
Equilibrium

**Somatic senses**
Touch/pressure
Temperature
Pain
Proprioception

*Subconscious*

**Somatic stimuli**
Muscle length and tension

**Visceral stimuli**
Blood pressure
pH/oxygen content in blood
pH of cerebrospinal fluid
Lung inflation
Osmolarity of body fluids
Blood glucose

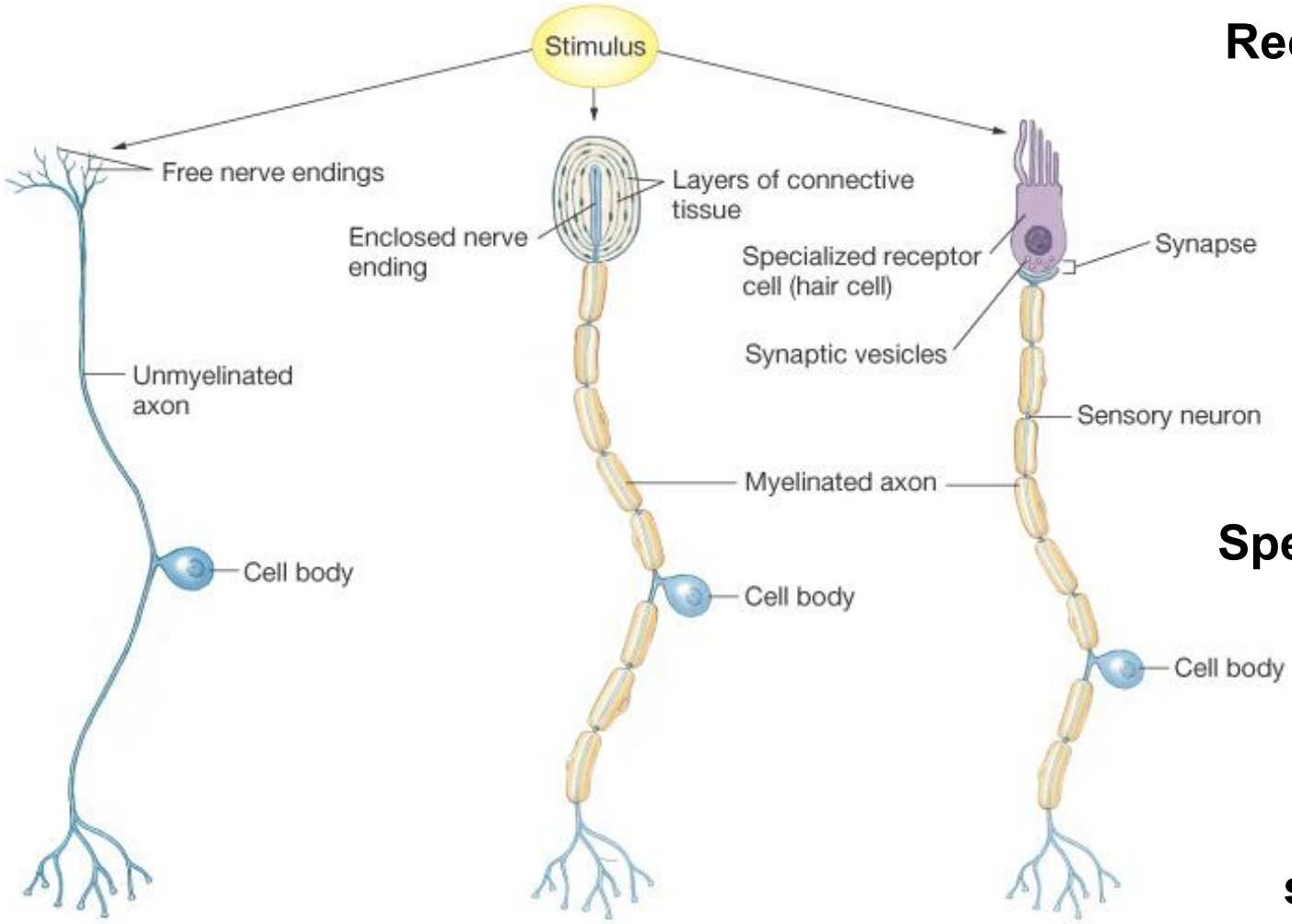
# Senses

- General senses
  - Pain
  - Temperature
  - Physical distortion
  - Chemical detection
    - Receptors for general senses scattered throughout the body
- Special senses
  - Located in specific sense organs
  - Structurally complex

# Sensory Physiology

- Sensations & Perceptions
  - sensation - is an awareness of sensory stimuli in brain
  - perception - meaningful interpretation or conscious understanding of sensory data

# Sensory Receptor Types




**(a) Simple receptors** are neurons with free nerve endings.

**(b) Complex neural receptors** have nerve endings enclosed in connective tissue capsules.

**(c)** Most **special senses receptors** are cells that release neurotransmitter onto sensory neurons, initiating an action potential.

**Receptor is part of neuron:**

**AP triggered if receptor potential above threshold**

**Specialized receptor cell:**

**Amount of NT released $\propto$ stimulus strength**

# 5 COMPONENTS of SENSORY PHYSIOLOGY

I. **Sensory modalities** (receptors)- structures that detect changes in external & internal environment
   - modified neurons or epithelial cells that have evolved to respond to stimuli (eye, ear, nose)

# 5 COMPONENTS of SENSORY PHYSIOLOGY

**II**. Reception - ability of receptor to absorb energy of a stimulus

**III**. Transduction - conversion of stimulus energy into membrane potential

**IV**. Transmission - receptor potentials transmitted via AP's to CNS

**V**. Integration - processing of frequency of receptor potentials

# Somatic sensibility has four major modalities

- ***discriminative touch*** -required to recognize the size, shape, and texture of objects and their movement across the skin.
- ***proprioception*** **-**the sense of static position and movement of the limbs and body.
- ***nociception*** -the signaling of tissue damage or chemical irritation, typically perceived as pain or itch.
- ***temperature sense*** -warmth and cold

# 4 Types of Sensory Receptors

1. **Chemo-** (specific ligands) **and Osmo-** (conc. of solutes)
2. **Mechano-** (touch, pressure, vibration, stretch)
3. **Thermo-** (temp. change)
   - **Cold receptors** **lower than body temp.**
   - **Warm receptors** **(37 - 45$^{o}$C)** **> 45$^{o}$C** ***?***
4. **Photo-** (light)

# Classes of Sensory Receptors

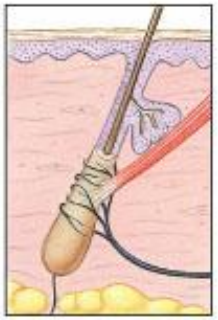
- **mechano-receptors**: mechanical forces - stretching alters membrane permeability
  (1) hair cells (deflection = depolarization = AP's)
  (2) stretch receptors of muscles
  (3) equilibrium receptor of inner ear
  (4) receptors of skin (touch, pain, cold, heat)
- **chemo-receptors**: chemicals sense solutes in solvents, taste, smell
- **osmo-receptors**: of hypothalmus which monitors blood osmotic pressure
- **photo-receptors**: light - eye
- **thermo-receptors**: radiant (heat) energy
- **phono-receptors**: sound waves
- **electro-receptors**: detect electric currents
- **noci-receptors**: pain receptors... naked dendrites of skin (epidermis)

# Thermoceptors and mechanoceptors

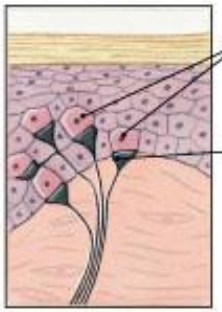
- Found in the dermis
- Mechanoceptors: sensitive to distortion of their membrane
  - 3 types
    - Tactile receptors (six types)
    - Baroreceptors
    - Proprioceptors (three groups)
      - Muscle spindles
      - Golgi tendon organs
      - Receptors in joint capsules

# Tactile Receptors in the Skin

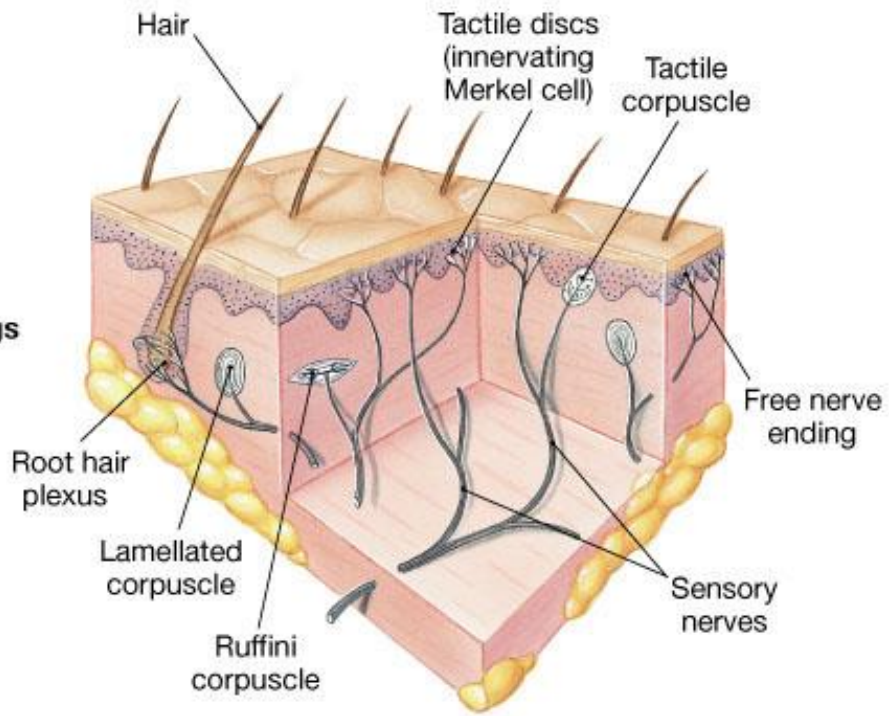
(a) Free nerve endings

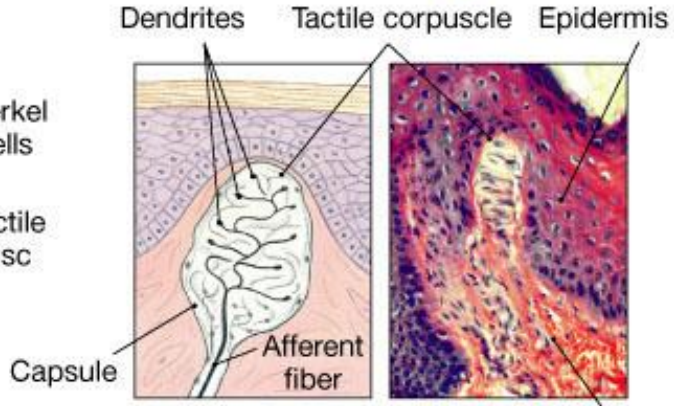


(b) Root hair plexus

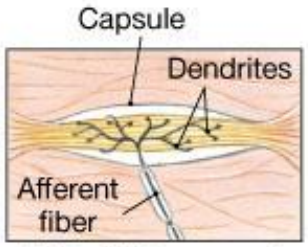


(c) Merkel cells and tactile discs

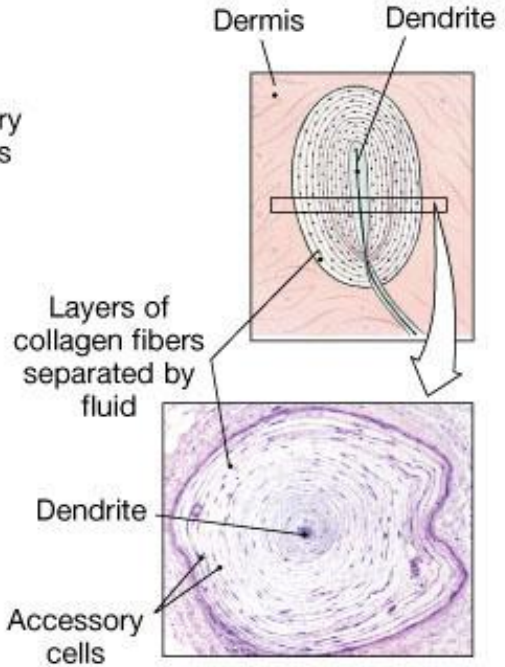



(d) Tactile corpuscle
LM × 330

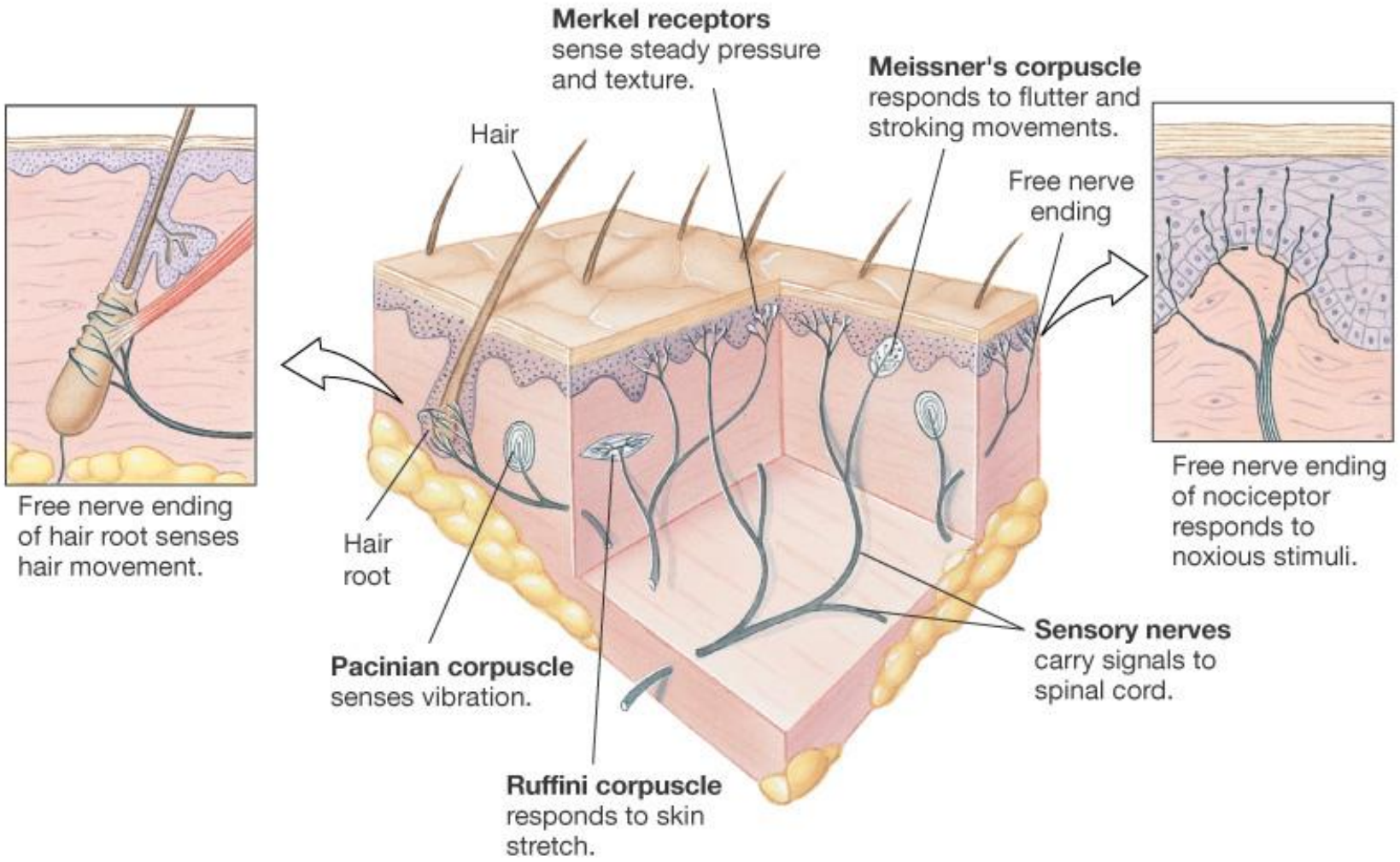



(f) Ruffini corpuscle

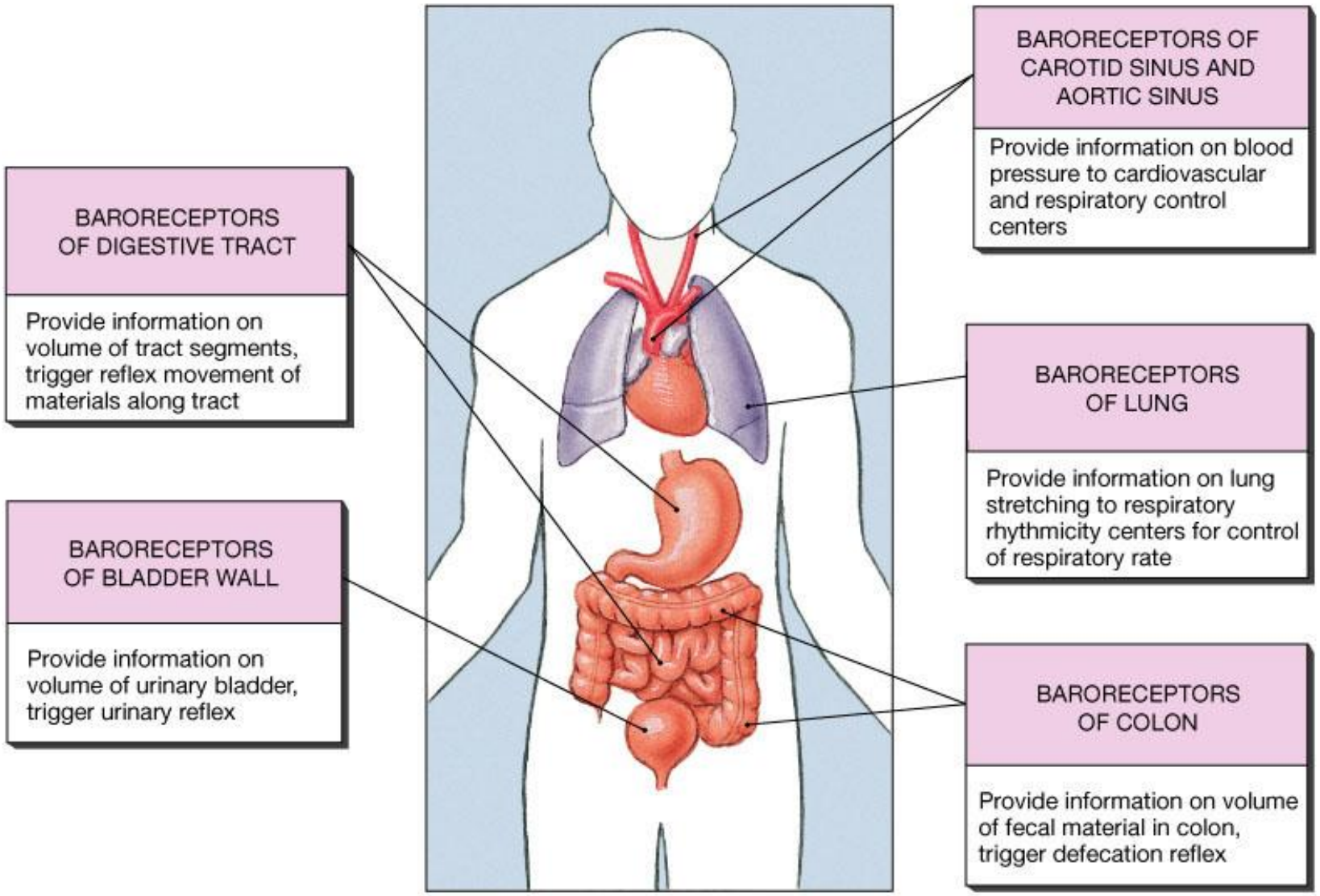



(e) Lamellated corpuscle
LM × 75

# Touch (pressure)



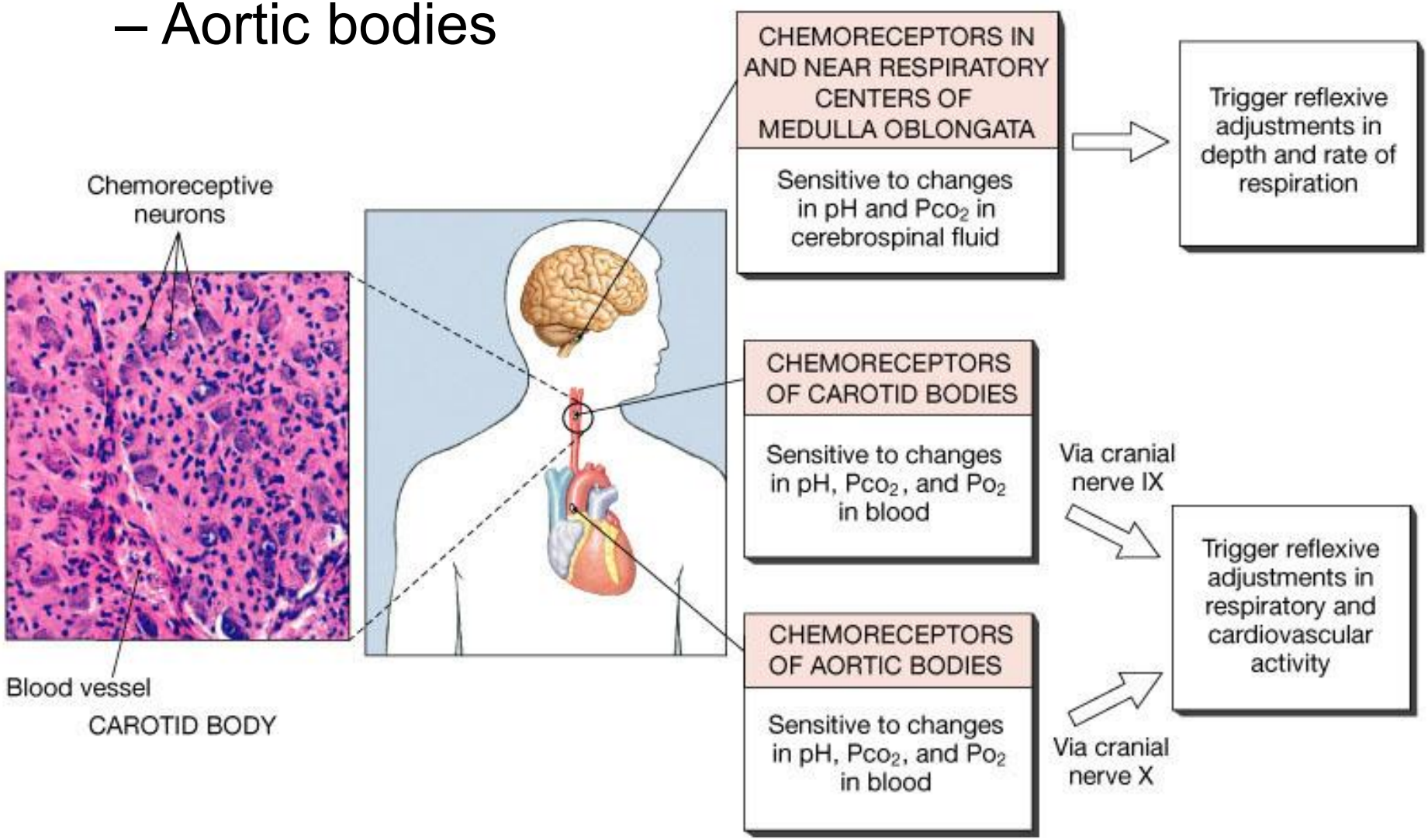
# Baroreceptors and the Regulation of Visceral Function


BARORECEPTORS OF CAROTID SINUS AND AORTIC SINUS
Provide information on blood pressure to cardiovascular and respiratory control centers
BARORECEPTORS OF DIGESTIVE TRACT
Provide information on volume of tract segments, trigger reflex movement of materials along tract
BARORECEPTORS OF LUNG
Provide information on lung stretching to respiratory rhythmicity centers for control of respiratory rate
BARORECEPTORS OF BLADDER WALL
Provide information on volume of urinary bladder, trigger urinary reflex
BARORECEPTORS OF COLON
Provide information on volume of fecal material in colon, trigger defecation reflex

# Chemoreceptors

– Carotid bodies

– Aortic bodies


Chemoreceptive neurons
Blood vessel
CAROTID BODY
CHEMORECEPTORS IN AND NEAR RESPIRATORY CENTERS OF MEDULLA OBLONGATA
Sensitive to changes in pH and $Pco_2$ in cerebrospinal fluid
Trigger reflexive adjustments in depth and rate of respiration
CHEMORECEPTORS OF CAROTID BODIES
Sensitive to changes in pH, $Pco_2$, and $Po_2$ in blood
Via cranial nerve IX
CHEMORECEPTORS OF AORTIC BODIES
Sensitive to changes in pH, $Pco_2$, and $Po_2$ in blood
Via cranial nerve X
Trigger reflexive adjustments in respiratory and cardiovascular activity

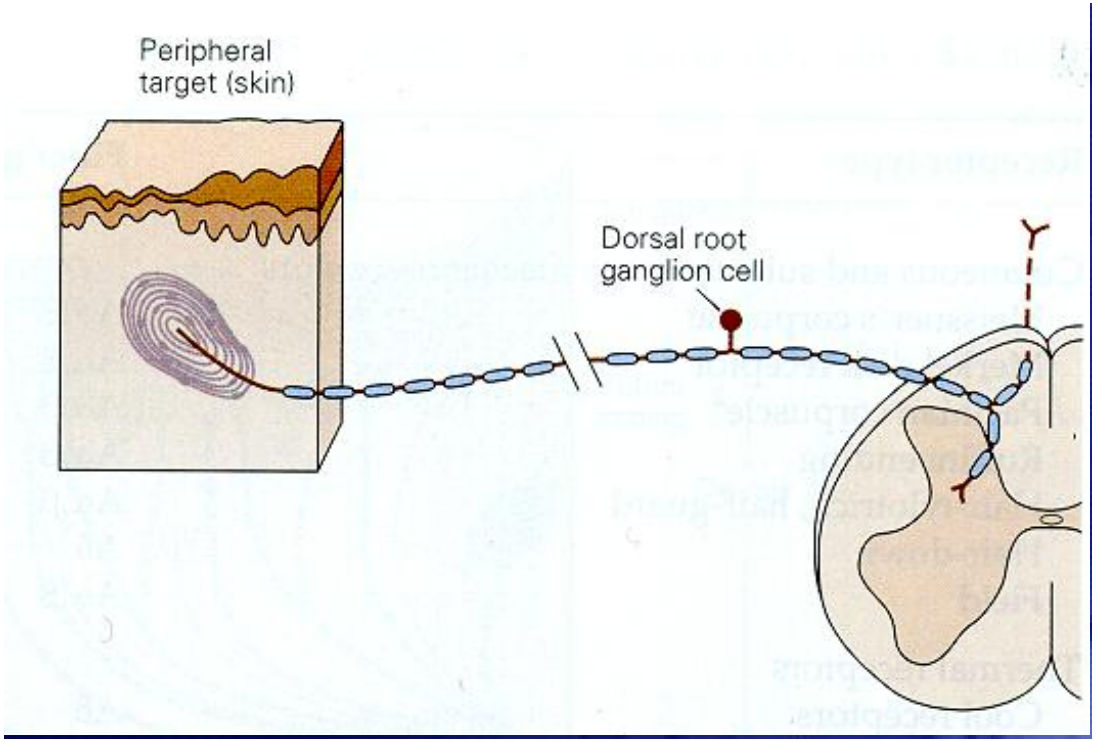
# Organization of Sensory Pathways

- First order neurons
  - Sensory neurons that deliver sensory information to the CNS
- Second order neurons
  - First order neurons synapse on these in the brain or spinal cord
- Third order neurons
  - Found in the thalamus
  - Second order neurons synapse on these

# Intensity & Duration of Stimulus

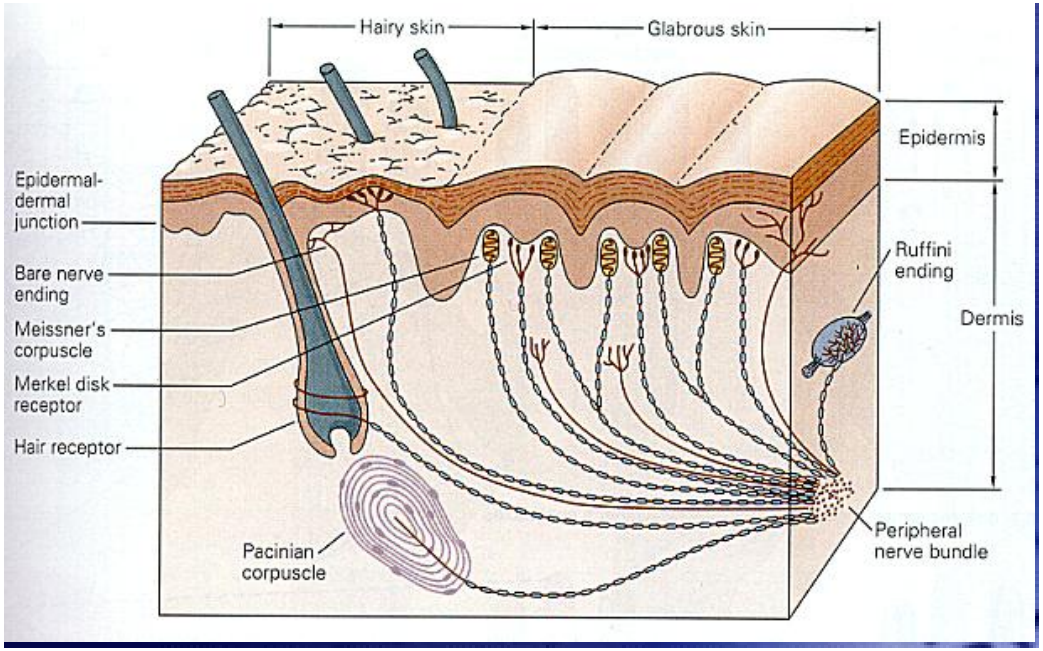
- **Intensity** is coded by # of receptors activated and frequency of AP coming from receptor
- **Duration** is coded by duration of APs in sensory neurons
- Sustained stimulation leads to adaptation
  - **Tonic receptors** do NOT adapt or adapt slowly
  - **Phasic receptors** adapt rapidly

- Irrespective of modality, all **somatosensory information** from the limbs and trunk is **conveyed by dorsal root ganglion neurons**
- The **terminal** of the peripheral **branch** of the axon is the **only portion** of the dorsal root ganglion cell **that is sensitive to natural stimuli.**



The peripheral terminals of dorsal root ganglion neurons are two types.

- The terminal may be a bare nerve ending or the nerve ending may be encapsulated by a nonneural structure.
- Dorsal root ganglion neurons with **encapsulated terminals mediate** the somatic modalities of **touch and proprioception.**
- In contrast, dorsal root ganglion neurons with **bare nerve endings mediate painful or thermal sensations.**



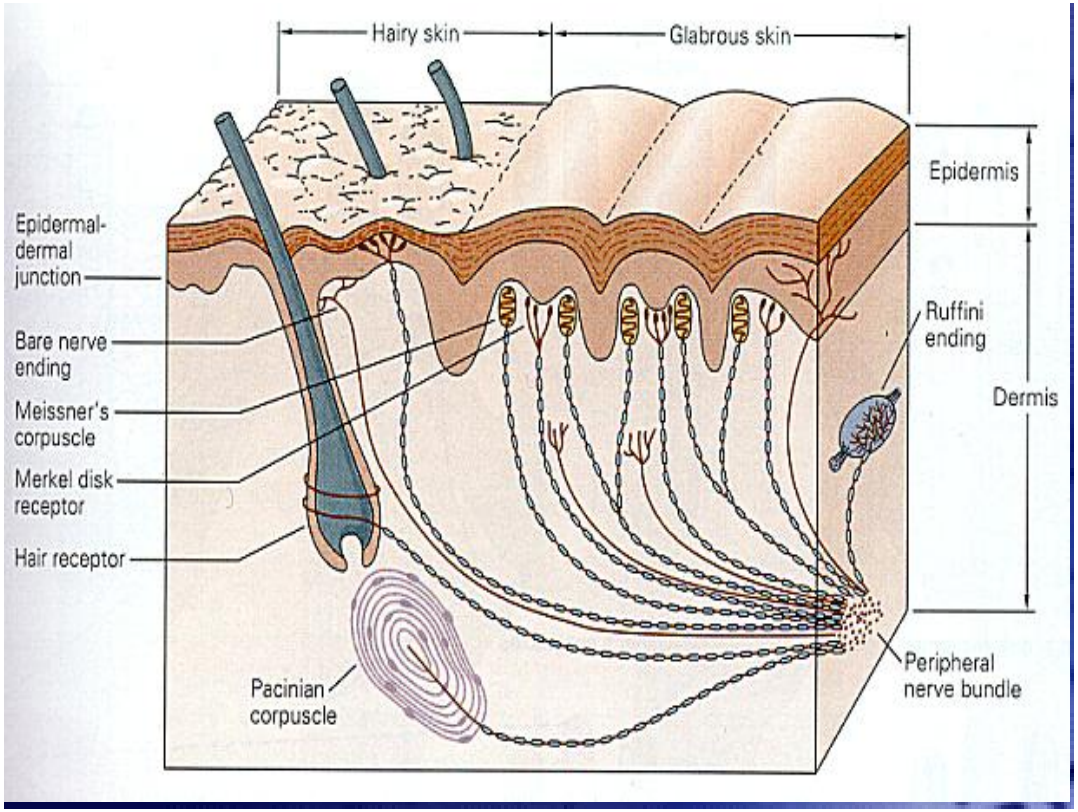
# Phasic vs. Tonic Receptors

- Phasic receptors- receptors that **adapt quickly to stimuli** meaning that they initially fire in the presence of a stimulus and then stop
  - are particularly **effective at conveying information about changes** in a stimulus (dynamic info).
- Tonic receptors- receptors that **slowly adapt convey information about the persistence of a stimulus** (static info.)

# Skin Receptors

The two principal mechanoreceptors in the **superficial layers** of the skin are the

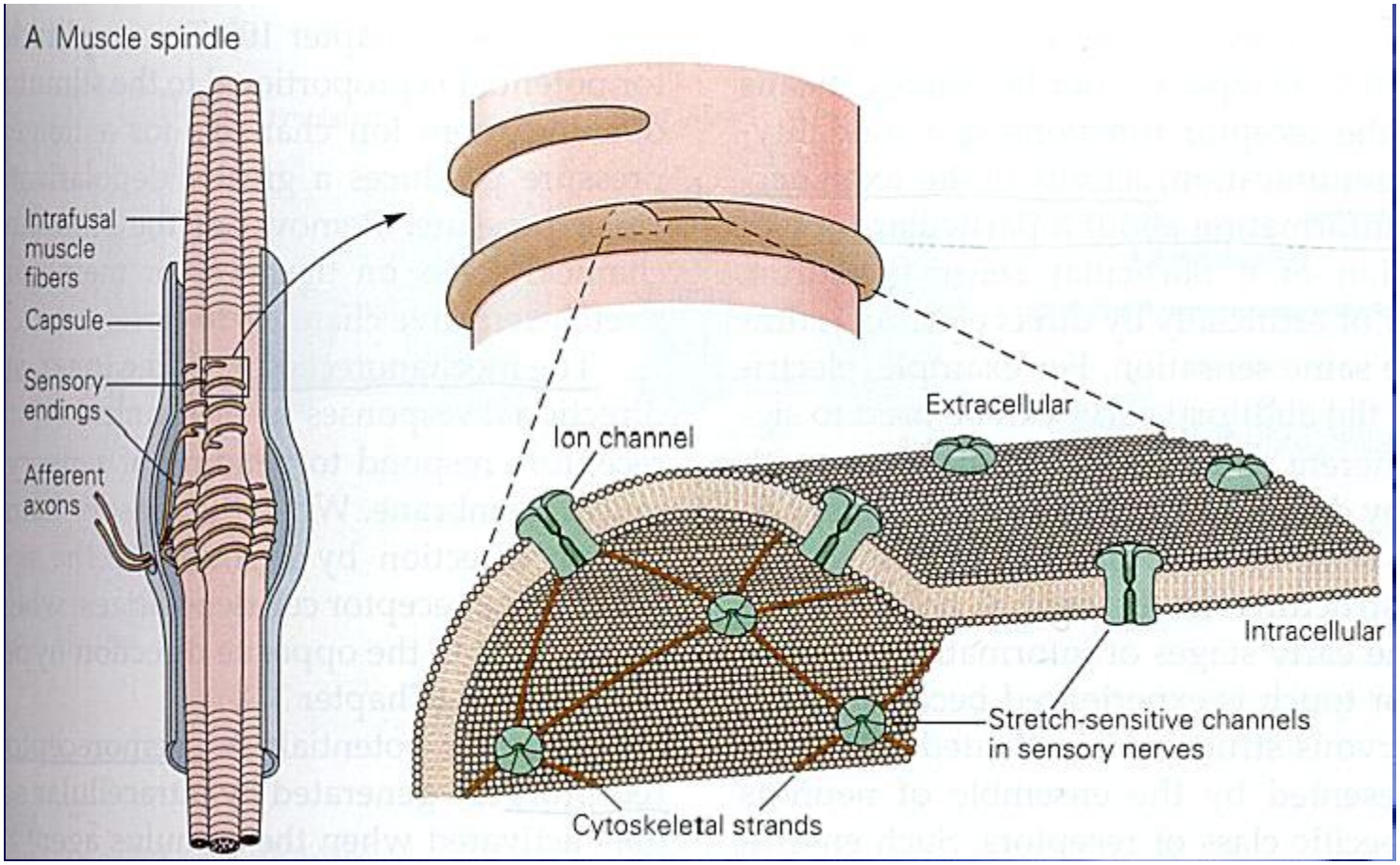
- **Meissner's corpuscle-**
  - **rapidly adapting receptor**, coupled mechanically to the edge of the papillary ridge, a relationship that confers **fine mechanical sensitivity.**
- **Merkel disk** receptor
  - encloses a semirigid structure that **transmits compressing strain** from the skin to the sensory nerve ending, evoking sustained, **slowly adapting response (sense steady pressure and texture)**



# Skin Receptors

- The two mechanoreceptors found in the deep subcutaneous tissue are the
- **Pacinian corpuscle**
  - The Pacinian corpuscle **responds to rapid indentation of the skin but not to steady pressure** because of the connective tissue lamellae that surround the nerve ending. (touching a tuning fork (oscillating at 200-300Hz) to the skin)
- **Ruffini ending (corpuscles)**
  - are **slowly adapting receptors** – respond to heavy touch, pressure, stretching, of skin, joint movement
    - (stretch of the skin or bending of the fingernails) Mechanical information sensed by
    - Ruffini ending contributes to our perception of the shape of grasped objects.

# Mechanoreceptors (Proprioceptors)




•Receptors **signal muscle length and the speed at which the muscle is stretched**.

•Consists of a bundle of specialized (intrafusal) muscle fibers enclosed by a capsule.

•The sensory nerve endings respond to stretch of the muscle fibers, producing the receptor potential.

# Receptor Field

- The region within which a tactile stimulus evokes a sensory response in the cell or its axon.
- Receptor fields vary:
  - receptive fields of mechanosensory neurons are 1-2mm in the fingertips, vs. 5-10 mm on the palms. This indicates that there are more encapsulated mechanoreceptors in the fingertips than in the palm.
  - Receptor fields can be measured by two-point-discrimination, (measure the minimal distance required between two points to perceive two stimuli as distinct.)

# Sensory Modality

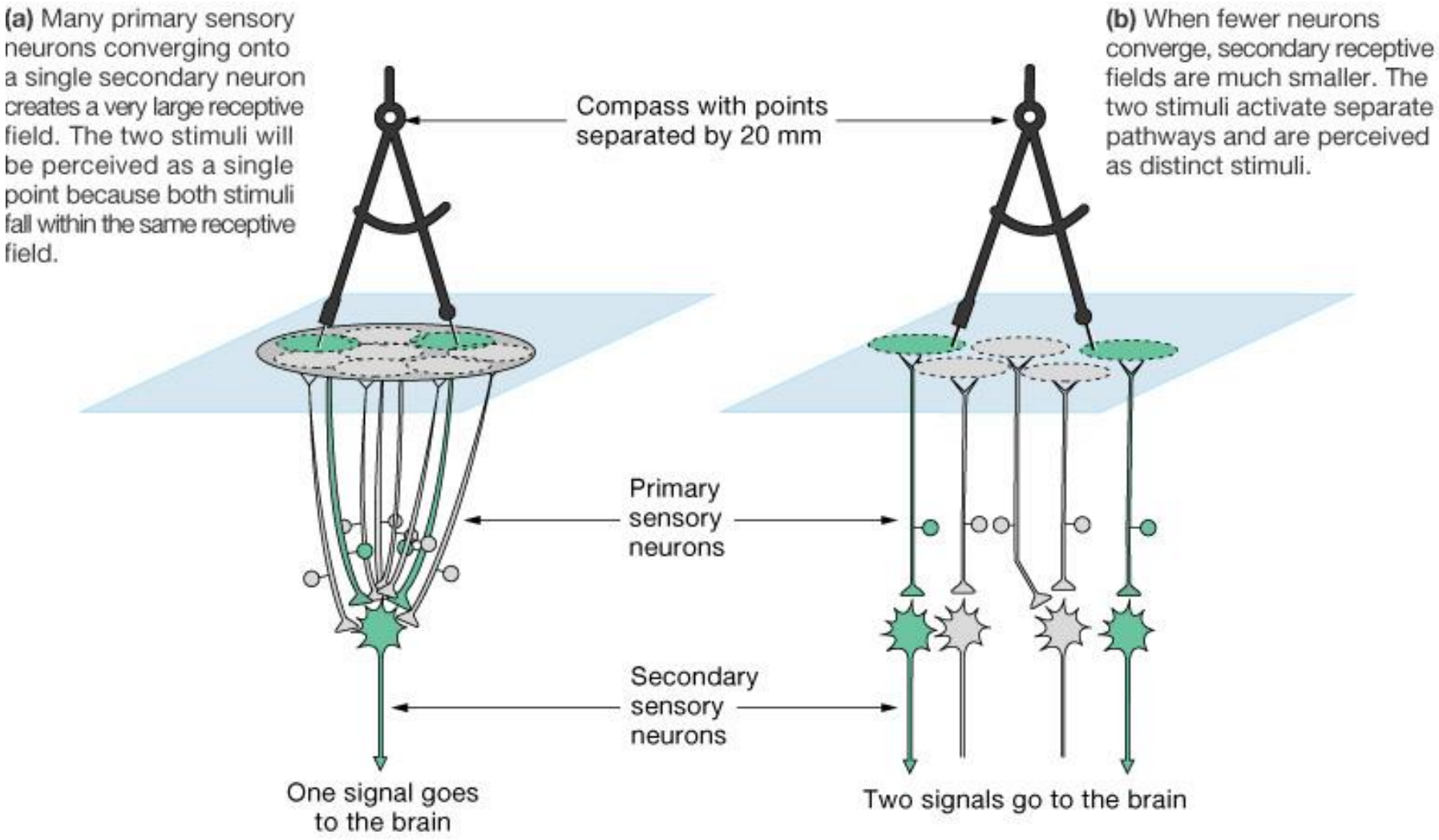

(a) Many primary sensory neurons converging onto a single secondary neuron creates a very large receptive field. The two stimuli will be perceived as a single point because both stimuli fall within the same receptive field.
(b) When fewer neurons converge, secondary receptive fields are much smaller. The two stimuli activate separate pathways and are perceived as distinct stimuli.
Compass with points separated by 20 mm
Primary sensory neurons
Secondary sensory neurons
One signal goes to the brain
Two signals go to the brain

Figure 10-3: Two-point discrimination

# Sensory Modality- Lateral Inhibition

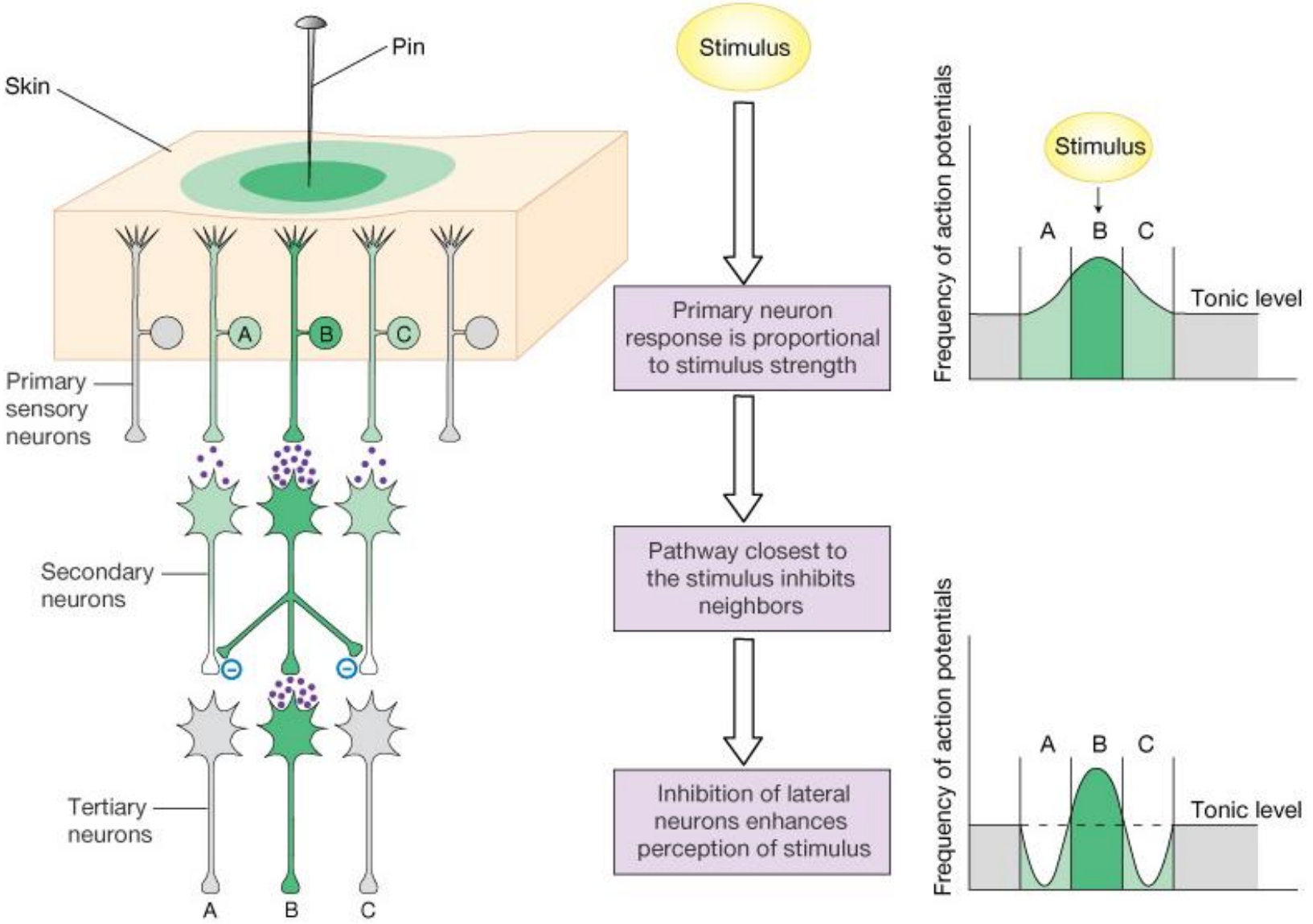
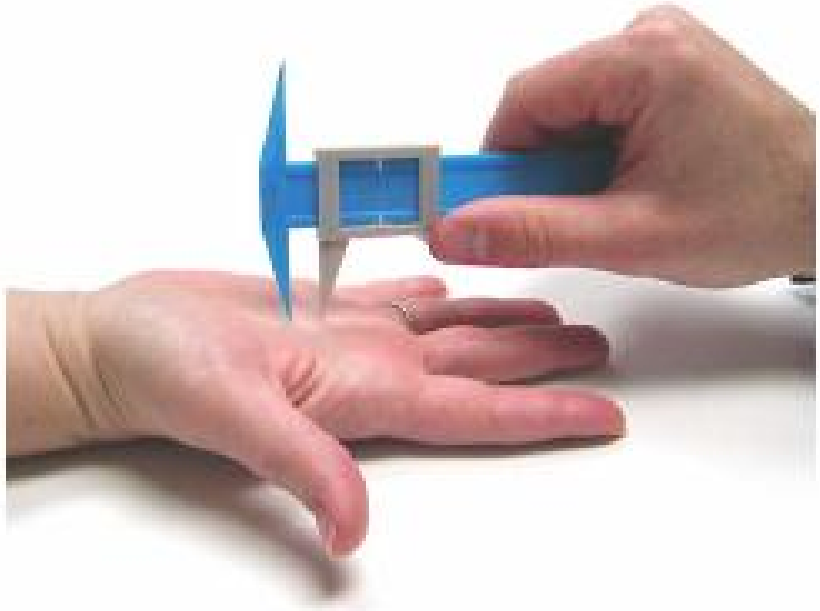



Figure 10-6: Lateral inhibition

# Two-Point Threshold:

- This test is used to measure the sensitivity to touch of an area of the skin. The "2-point threshold" is defined as the smallest amount of separation between 2 points touching the skin that produces 2 distinct impressions of touch.

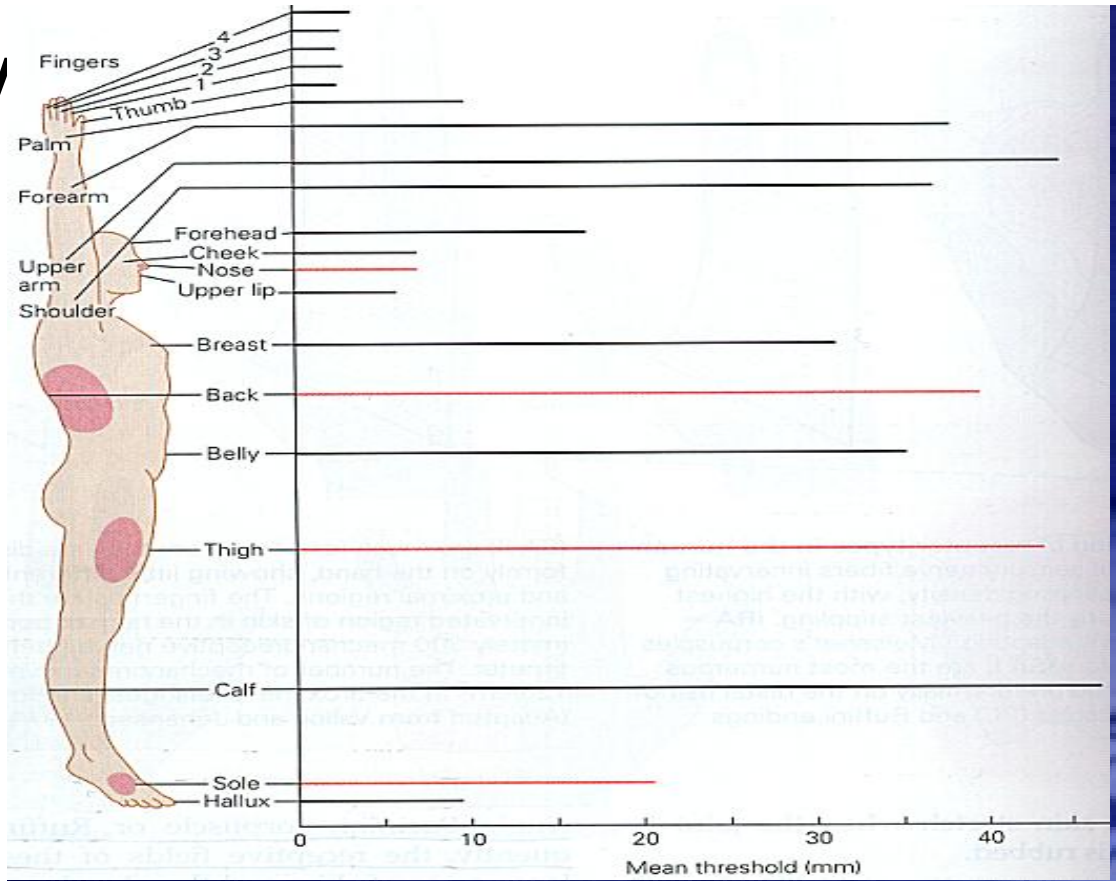


# Touch Receptors:

- There are more touch receptors in some areas of our bodies compared to other areas.
- The size and density of receptors vary in different areas of the body. The 2-point threshold will be smaller for areas that are more sensitive.

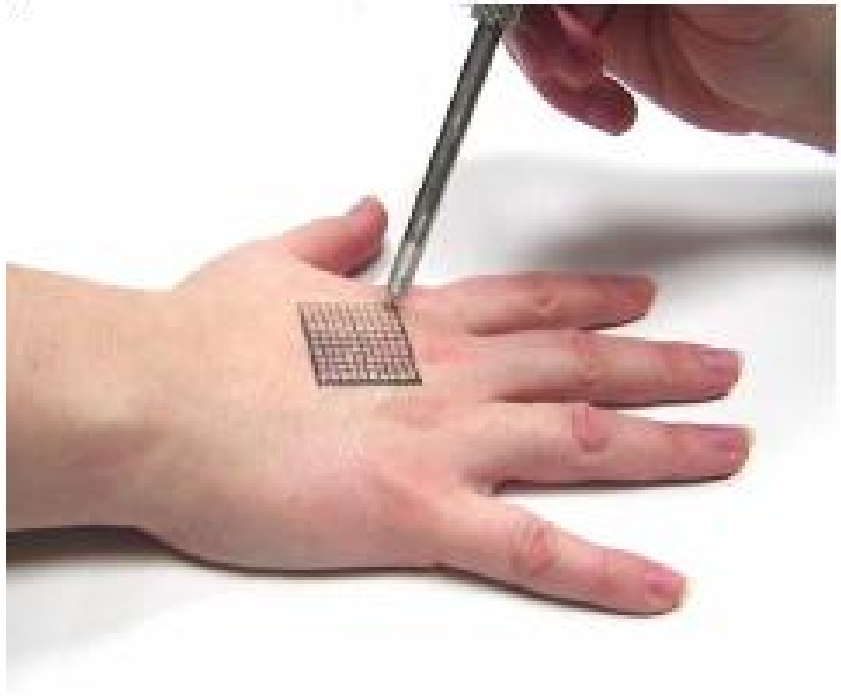
# Two-Point Discrimination

- The two-point threshold **varies for different body regions**;
- it is about **2㎜ on the finger tip** but increases to **10㎜ on the palm** and **40㎜ on the arm**.
- These variations are **correlated with the size of sensory receptive fields and the innervation density** of mechanoreceptors in the superficial layers of the skin.



# Cutaneous Sensitivity to Cold:

- Cutaneous thermoreceptors are free nerve endings that respond to particular ranges of temperatures and changes within those ranges. Separate locations on the skin are sensitive to hot or to cold, or are not sensitive to temperature at all.



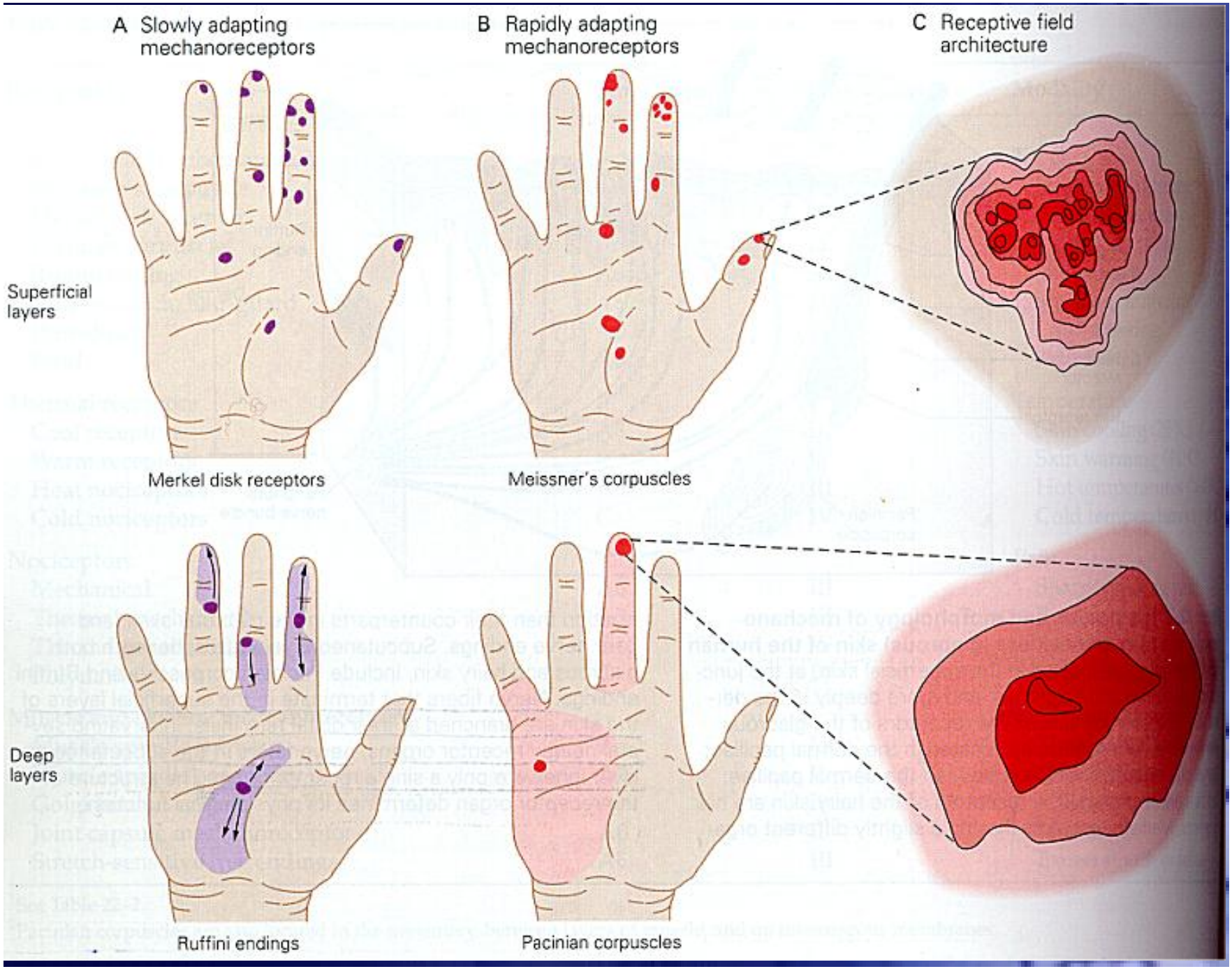
# Temperature Receptors:

- **Temperature sensitivity** is **not uniformly distributed**.
- **Cold receptors** are **unevenly distributed** throughout the dermis and subcutaneous layer of the skin. **Warmth receptors** are **deeper and less numerous**.
- **Temperature receptors** show adaptation over time as the body adjusts.

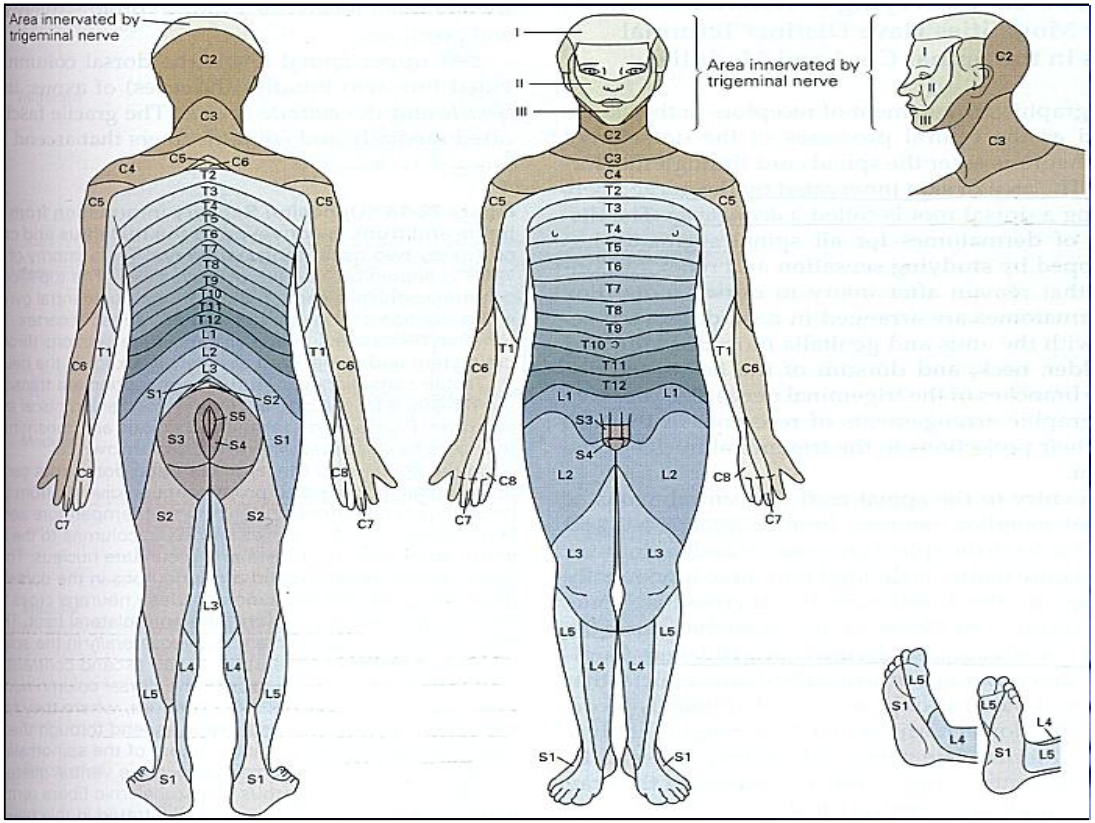
# Adpatation

When the frequency of receptor firing declines after prolonged stimulus exposure

- **Tonic receptors adapt slowly** and generate nerve impulses more steadily
  - **prorpioceptors** are among **the most slowly adapting** tonic receptor because the brain must always be aware of body position, muscle tension and joint motions
- Phasic receptors generate a bust of action potentials when first stimulated, then **quickly adapt** and sharply reduce or halt signal transmission even if stimulus continues
  - lamellated corpuscles, tactile receptors, hair receptors, and smell receptors are rapidly adapting


A Slowly adapting mechanoreceptors
B Rapidly adapting mechanoreceptors
C Receptive field architecture
Superficial layers
Merkel disk receptors
Meissner's corpuscles
Deep layers
Ruffini endings
Pacinian corpuscles

- The area of skin innervated by a single dorsal root, known as a **dermatome**,
- Dermatomal maps are an important diagnostic tool for locating the site of injury to the spinal cord and dorsal roots.



# Adaptation Curves For Sensory Receptors

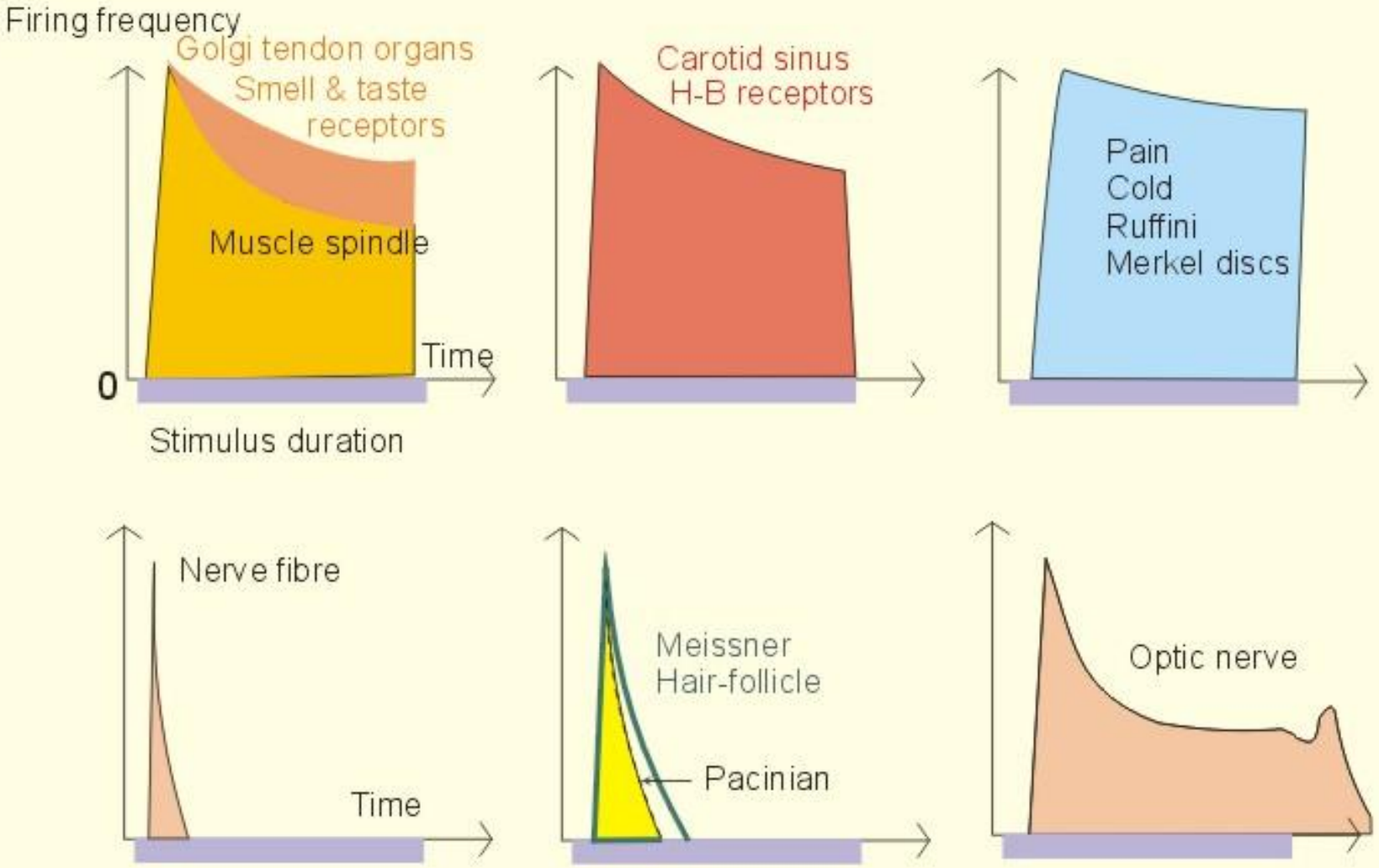



Fig. 3-4

KMc

# Proprioceptors

(meaning "reception for self")

- Provide information about mechanical forces arising from with the body (particularly the musculoskeletal system).
- Their purpose is to provide detailed and consistent information about the position of the limbs in space.

There are three low-threshold proprioceptors:

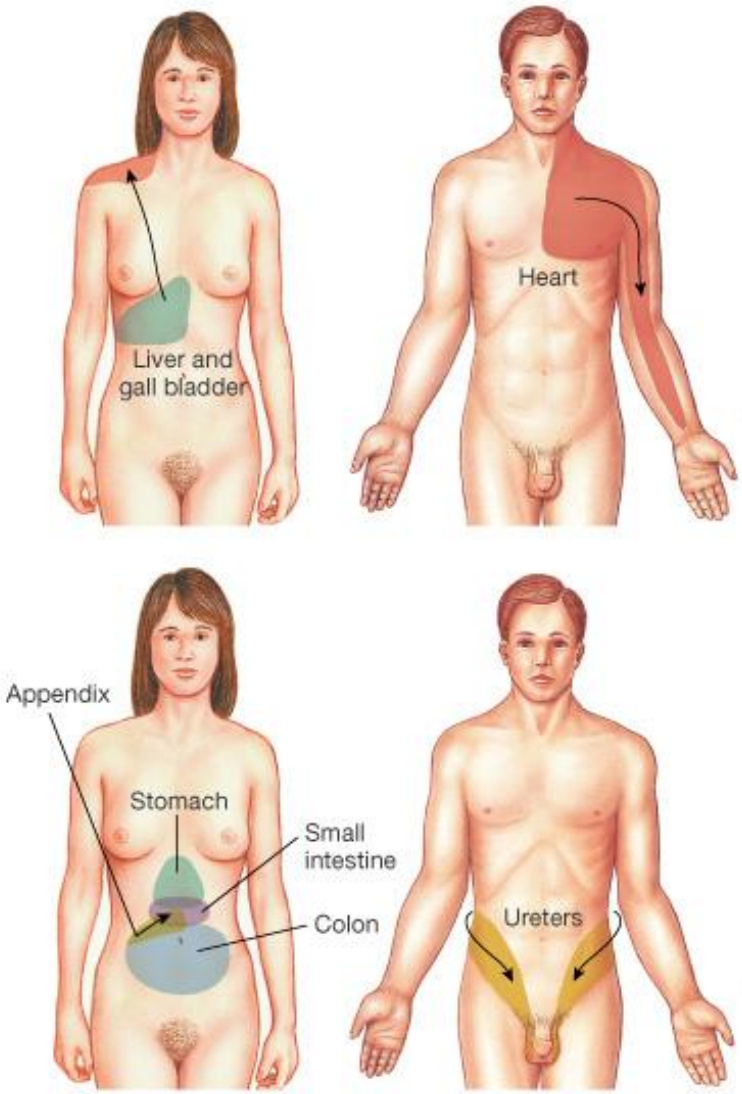
1) **Muscle spindles**:
   - **located in skeletal muscle**, they are especially numerous in extraocular muscles and intrinsic muscles of the hand and neck.
   - **signal changes in muscle length**

2) **Golgi tendon organs**:
   - distributed among collagen fibers that form **tendons**
     job
   - inform CNS about **changes in mm tension**

3) **Joint receptors**
   - located **in and around joints**
   - gathers **info about limb position and joint movement** (function is not well understood)

# Referred Pain

**(a)** Pain in internal organs is often sensed on the surface of the body, a sensation known as **referred pain**.




**(b)** One theory of referred pain says that nociceptors from several locations converge on a single ascending tract in the spinal cord. Pain signals from the skin are more common than pain from internal organs, and the brain associates activation of the pathway with pain in the skin. Adapted from H.L. Fields, *Pain* (McGraw Hill, 1987).

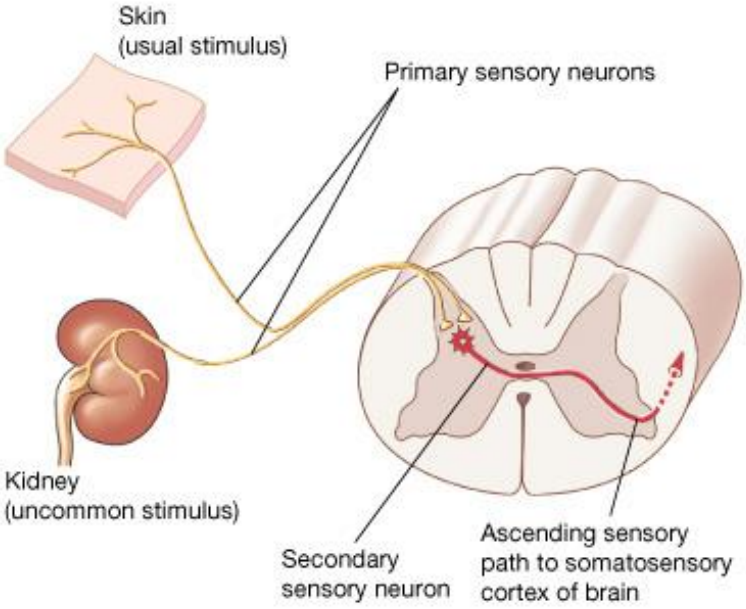



Figure 10-13: Referred pain

# Somatosensory System

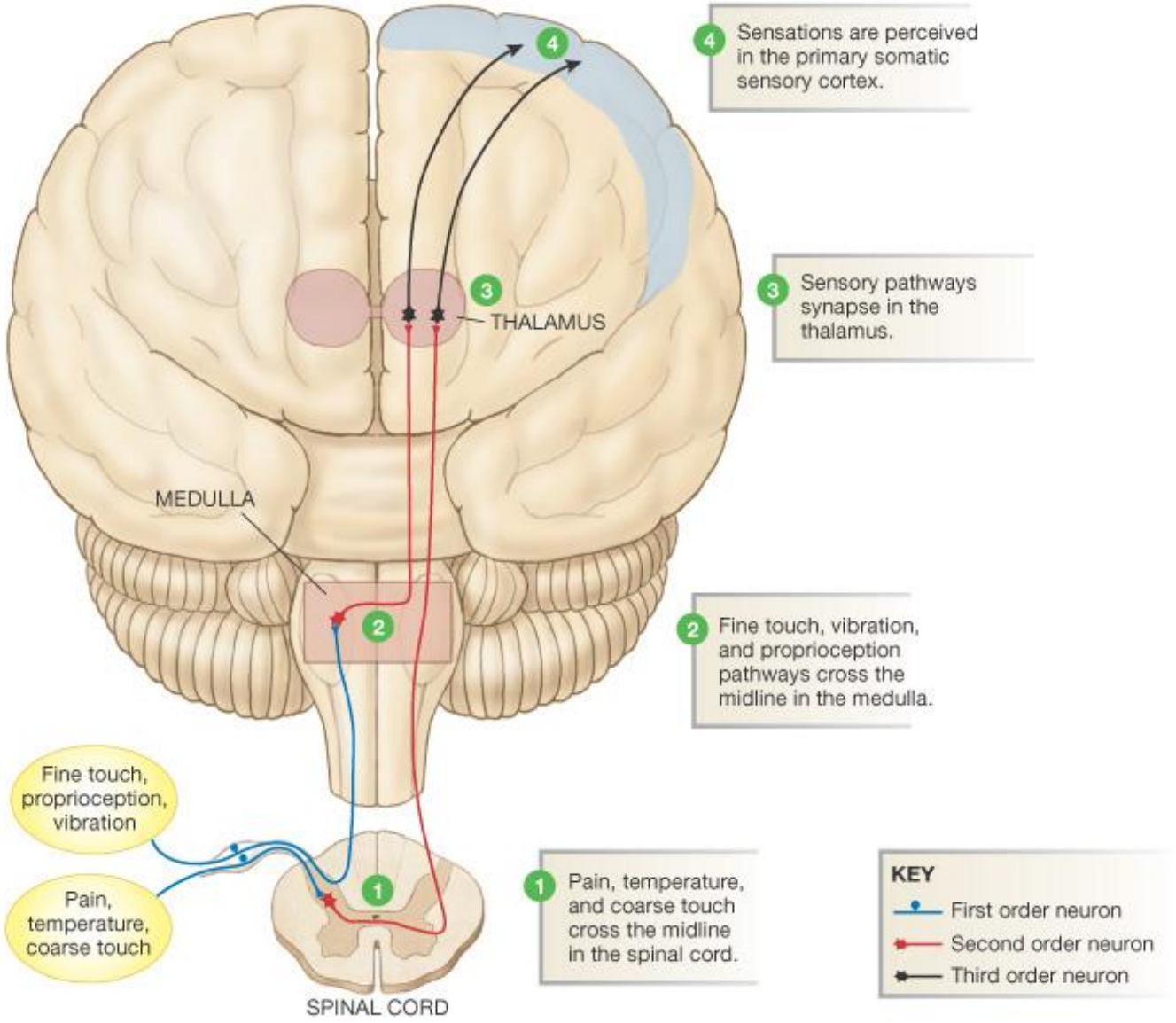
These sensory modalities are lumped into three different pathways in the spinal cord and have different targets in the brain.

- **Discriminative touch-** includes touch, pressure, and vibration perception, and enables us to "read" raised letters with our fingertips, or describe the shape and texture of an object without seeing it.
- **Pain and temperature**,
- **Proprioception-** includes receptors for what happens below the body surface: muscle stretch, joint position, tendon tension, etc.
  - This modality primarily targets the **cerebellum**, which needs minute-by-minute feedback on what the muscles are doing.

# Somatosensory System

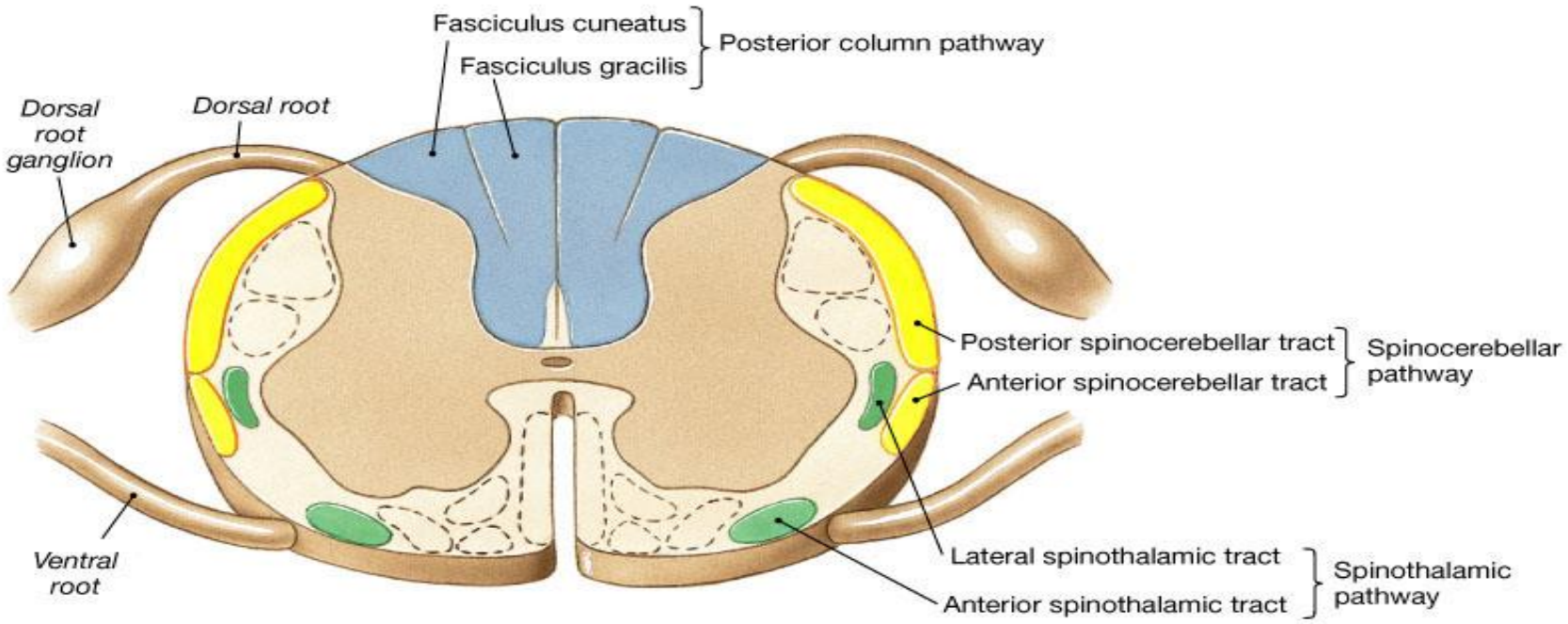
- These modalities differ in their receptors, pathways, and targets, and also in the level of crossing.
- Any sensory system going to the cerebral cortex will have to **cross over at some point**, because the cerebral cortex operates on a contralateral (opposite side) basis.
- The **discriminative touch system crosses high** - in the medulla.
- The **pain system crosses low** - in the spinal cord.
- The **proprioceptive system is going to the cerebellum**, which (surprise!) works ipsilaterally (same side). Therefore this system **doesn't cross**.

# Somatic Pathways



# Somatic sensory pathways

- Three major pathways carry sensory information
  - Posterior column pathway
  - Anterolateral pathway
  - Spinocerebellar pathway



# Posterior column pathway

- Carries fine touch, pressure and proprioceptive sensations
- Axons ascend within the **fasciculus gracilis** and **fasciculus cuneatus**
- Relay information to the thalamus via the **medial lemniscus**
  - Decussation

# Anterolateral pathway

- **Carries poorly localized sensations of touch, pressure, pain, and temperature**
- Axons **decussate in the spinal cord** and ascend within the **anterior and lateral spinothalamic tracts**
- Headed toward the **ventral nuclei of the thalamus**

# Spinocerebellar pathway

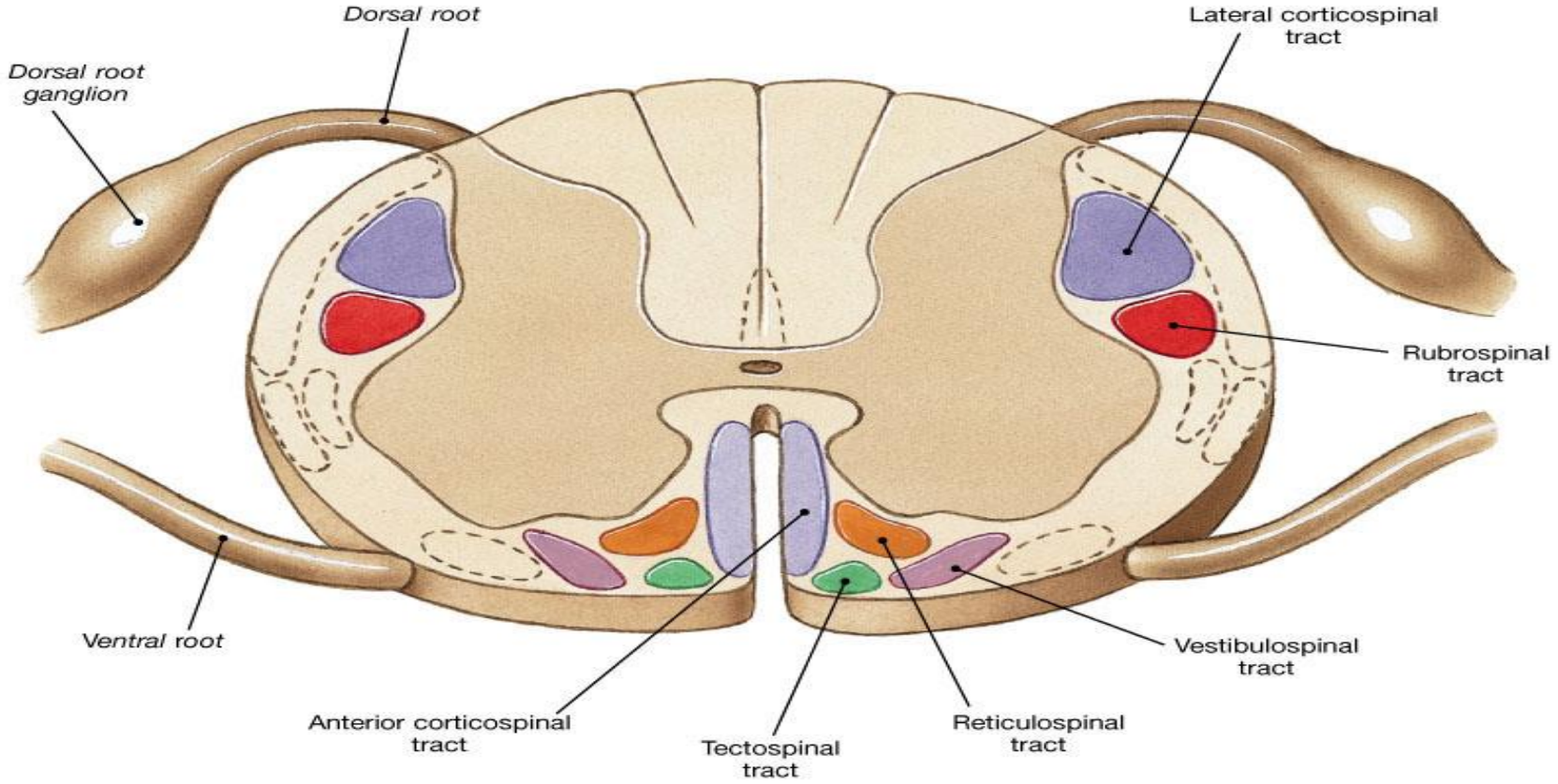
- Includes the posterior and anterior spinocerebellar tracts
- Carries sensation to the cerebellum concerning position of muscles, tendons and joints

# Visceral sensory pathways

- Carry information collected by **interoceptors**
- Information from cranial nerves **V, VII, IX and X** delivered to solitary nucleus in medulla oblongata
- Dorsal roots of spinal nerves **T1 – L2** carry visceral sensory **information** from organs **between the diaphragm and pelvis**
- Dorsal roots of spinal nerves **S2 – S4** carry sensory **information below this area**

# The Somatic Nervous System

- Upper motor neuron: Cell body lies in a CNS processing center
- Lower motor neuron: Cell body located in a motor nucleus of the brain or spinal cord



# The corticospinal pathway

- Provides voluntary skeletal muscle control
- Corticobulbar tracts terminate at cranial nerve nuclei
- Corticospinal tracts synapse on motor neurons in the anterior gray horns of the spinal cord
  - Visible along medulla as pyramids
    - Most of the axons decussate to enter the descending lateral corticospinal tracts
    - Those that do not cross over enter the anterior corticospinal tracts
    - Provide rapid direct method for controlling skeletal muscle

# medial and lateral pathways

- Issue motor commands as a result of subconscious processing
- Medial pathway
  - Primarily controls gross movements of the trunk and proximal limbs
  - Includes the vestibulospinal tracts, tectospinal tracts and reticulospinal tracts
- Lateral pathway
  - Controls muscle tone and movements of the distal muscles of the upper limbs
  - Rubrospinal tracts

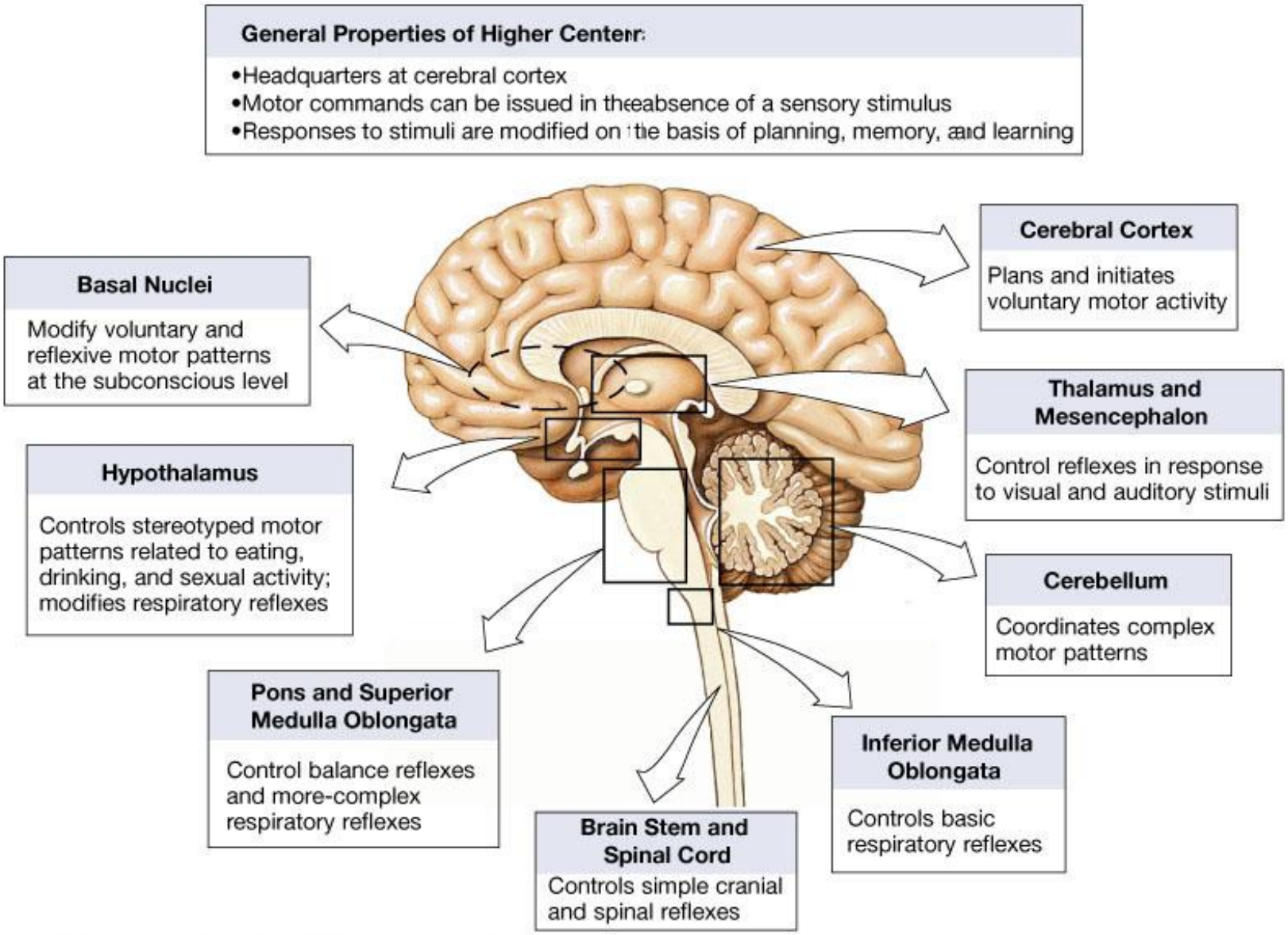
# The basal nuclei and cerebellum

- Basal nuclei adjust motor commands issued in other processing centers
- Provide background patterns of movement involved in voluntary motor movements
- Cerebellum monitors proprioceptive information, visual information and vestibular sensations

# control and responses

- Levels of processing and motor control
  - Spinal and cranial reflexes provide rapid, involuntary, preprogrammed responses
- Voluntary responses
  - More complex
  - Require more time to prepare and execute

# Centers of Somatic Motor Control


General Properties of Higher Centers
•Headquarters at cerebral cortex
•Motor commands can be issued in the absence of a sensory stimulus
•Responses to stimuli are modified on the basis of planning, memory, and learning
Cerebral Cortex
Plans and initiates voluntary motor activity
Basal Nuclei
Modify voluntary and reflexive motor patterns at the subconscious level
Thalamus and Mesencephalon
Control reflexes in response to visual and auditory stimuli
Hypothalamus
Controls stereotyped motor patterns related to eating, drinking, and sexual activity; modifies respiratory reflexes
Cerebellum
Coordinates complex motor patterns
Pons and Superior Medulla Oblongata
Control balance reflexes and more-complex respiratory reflexes
Inferior Medulla Oblongata
Controls basic respiratory reflexes
Brain Stem and Spinal Cord
Controls simple cranial and spinal reflexes

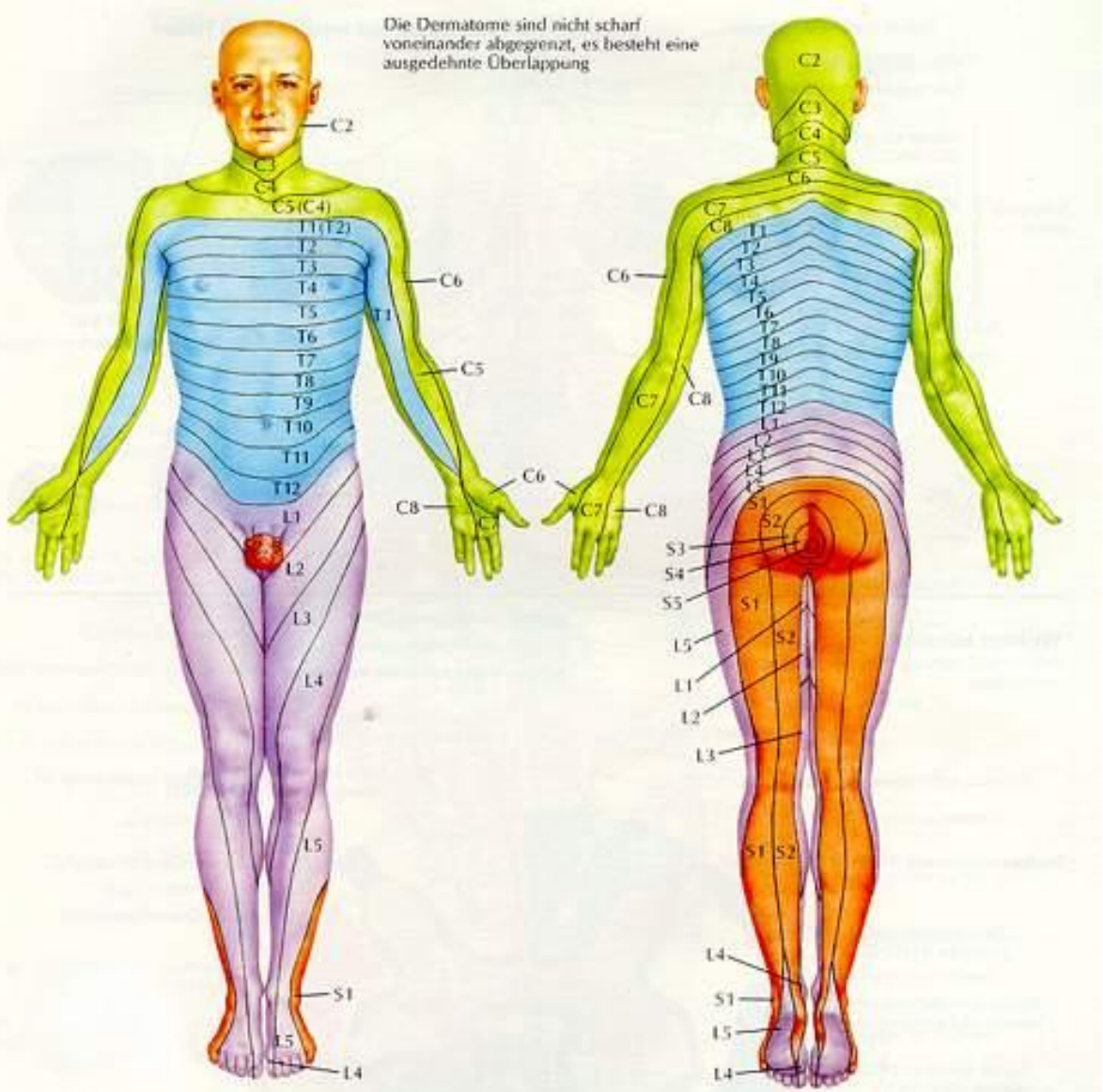
# During development

- Spinal and cranial reflexes are first to appear
- Complex reflexes develop as CNS matures and brain grows

# Somatic Reflexes

# Cutaneous Innervation and Dermatomes

- each spinal nerve except C1 receives sensory input from a specific area of skin called a **dermatome**
- dermoatomes overlap in their edges by as much as 50%, therefore severance of onw sensory nerve root does not entirely deaden sensation from a dermatome.
- Spinal nerve damage is assessed by testing the dermatomes with pinpricks and noting areas in which the patient has no sensation




## Anordnung der Dermatome

| | |
|---|---|
| **C 5 (C 4)** | Höhe der Clavicula |
| **C 5, 6, 7** | Laterale Seite des Armes |
| **C 8, T 1** | Mediale Seite des Armes |
| **C 6** | Daumen |
| **C 6, 7, 8** | Hand |
| **C 8** | 4. und 5. Finger |
| **T 4** | Höhe der Mamilla |
| **T 10** | Nabelhöhe |
| **T 12** | Leistengegend |
| **L 1, 2, 3, 4** | Vorder- und Innenfläche des Beines |
| **L 4, 5, S 1** | Fuß |
| **L 4** | Mediale Fußkante |
| **S 1, 2, L 5** | Hinter- und Außenfläche des Beines |
| **S 1** | Laterale Fußkante |
| **S 2, 3, 4** | Anogenital-Bereich |

# Somatic Reflexes

- Reflexes are quick, involuntary, stereotyped reactions of glands or muscles to stimulation
- Four important properties of reflexes
  - **reflexes require stimulation-** they are not spontaneous
  - **reflexes are quick-** involve few if any interneurons and miminum synaptic delay
  - **reflexes are involuntary-** they occur without intent, or awareness, and are difficult to suppress
  - **reflexes are stereotyped-** they occur in essentially the same way every time.

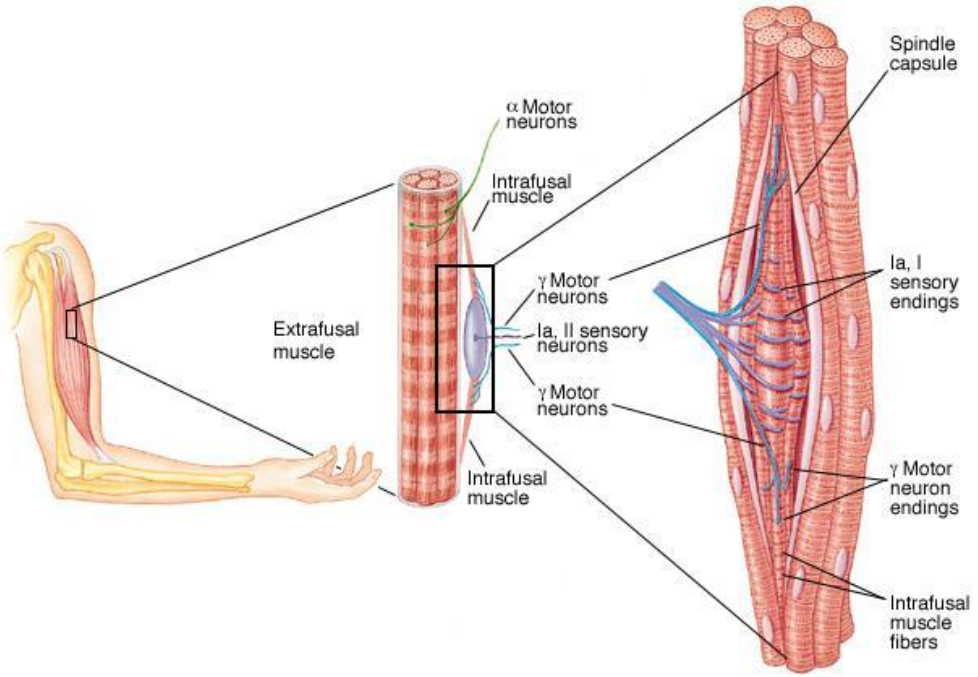
# Somatic Reflexes

Somatic reflex employ a **reflex arc**

- **somatic receptors** in the skin, muscle or a tendon
- **afferent nerve fibers-** carry information from receptors into the dorsal horn of the cord
- **interneurons**- integrate information (lacking in some reflexes)
- **efferent nerve fibers-** carry motor impulses to the skeletal muscle
- **skeletal muscle-** the somatic effectors that carry out the response

# Somatic Receptor: Muscle Spindle

- are stretch receptors in the muscle
  - a type of **proprioceptor**- sense organs that monitor the position and movements of body parts
- more abundant in muscles that require fine control



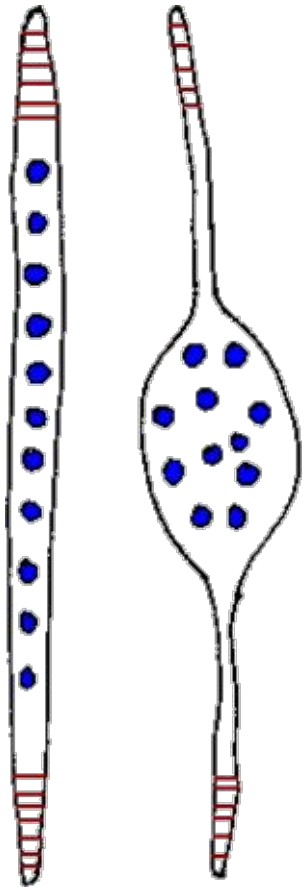
# Muscle Spindle

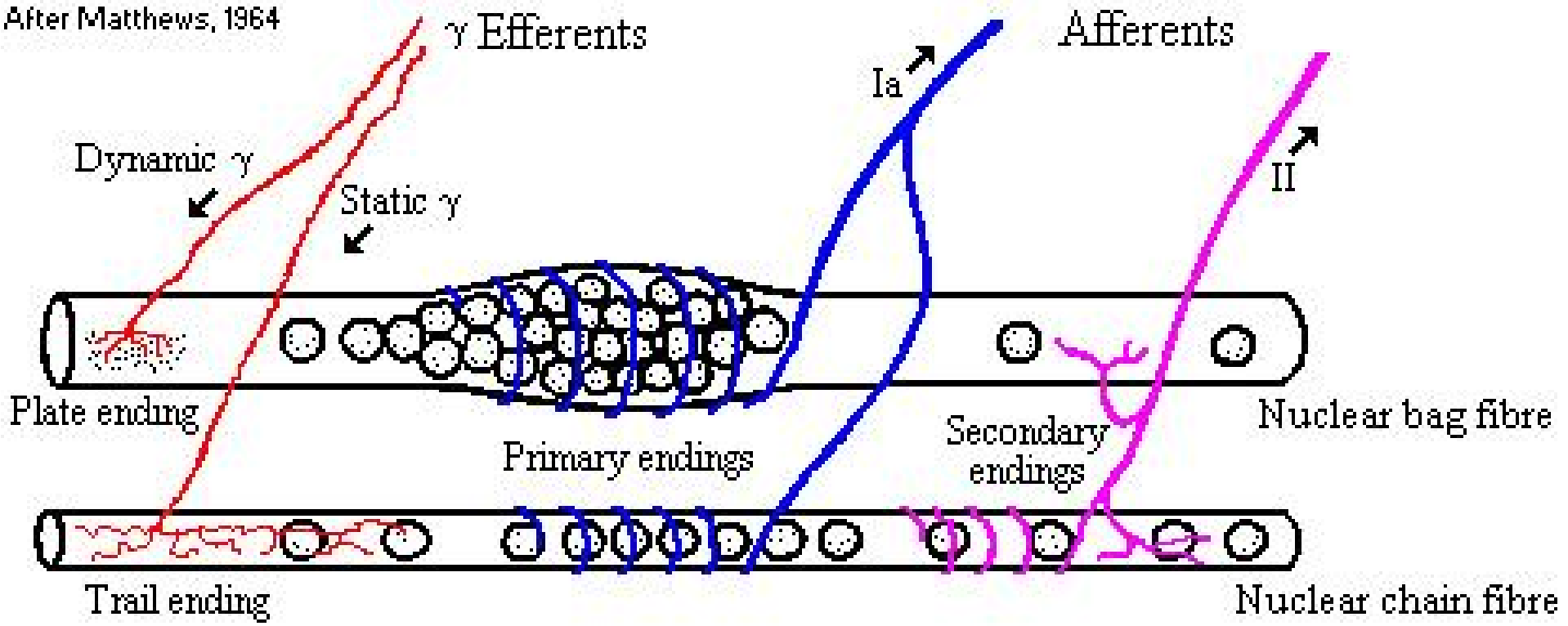
- consist of modified muscle fibers (**intrafusal fibers** to distinguish them from **extrafusal fibers**, i.e. the rest of the muscle)
- only the two ends of an intrafusal fiber have sarcomeres and are able to contract
- middle portion acts as a stretch receptor

# Muscle Spindle

Two types of intrafusal muscle fibers based anatomically on the location of their nuclei

- **Nuclear bag-** the nuclei are located in the center of the fiber, which bulges out into a bag.
- **Nuclear chain-** the nuclei spread out along the fiber like a chain.
- Only the ends of the intrafusal fibers contain sarcomeres and are able to contract



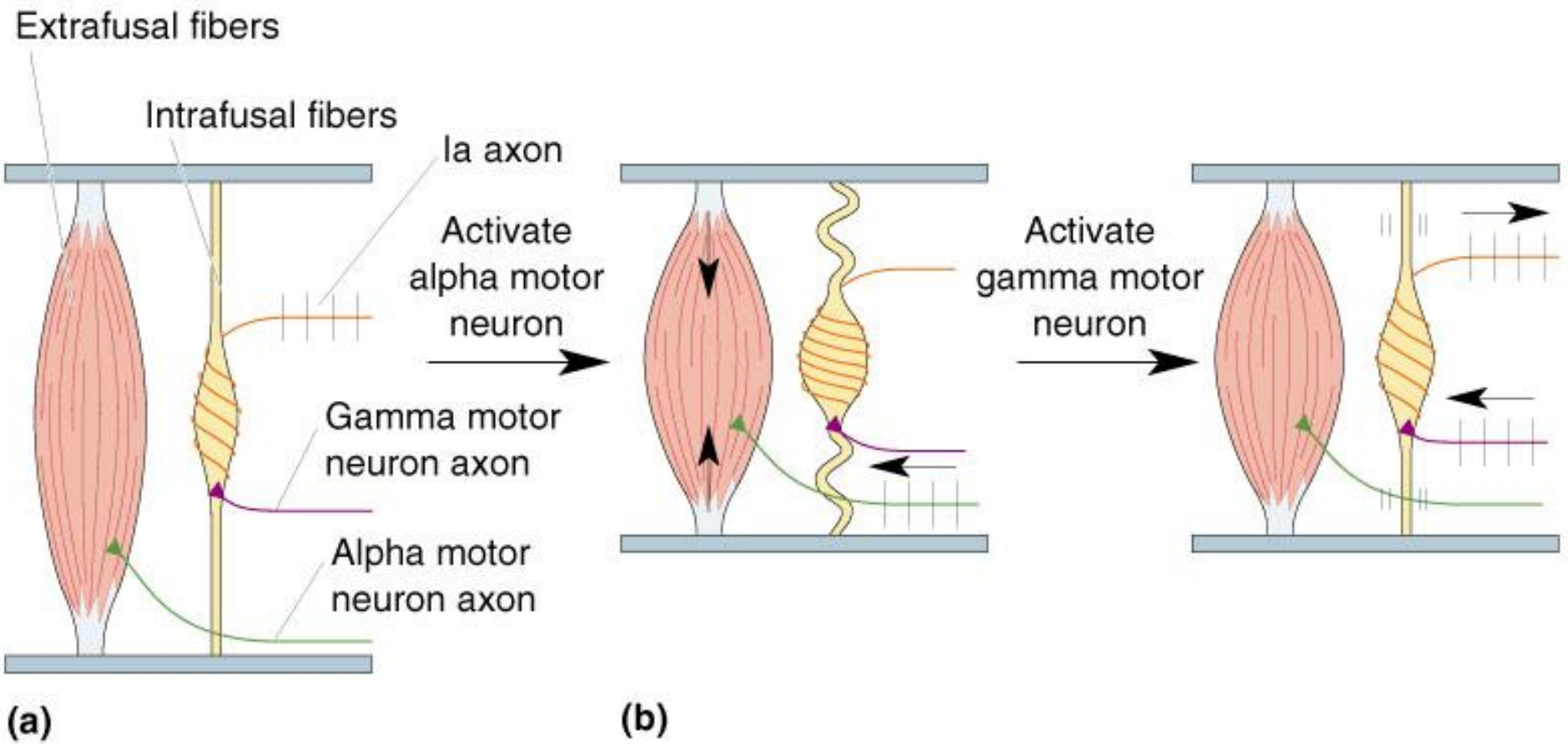



# Have three types of nerve fibers

- Both contain **primary afferent nerve fibers (Ia)** which end in annulospiral fibers that coil around middle that **respond mainly to muscle stretch**
- **secondary afferent nerve fibers** wrap primarily around the ends of nuclear chain fibers that **respond mainly to prolonged strecth**
- **gamma motor neurons fibers** which innervate the ends of the intrafusal fibers (constitutes about 1/3 of fibers in a spinal nerve)

# Adjustment of Length of intrafusal fibers by Gamma fibers

**Figure 13.19**
**The function of gamma motor neurons. (a) Activation of alpha motor neurons shortens the extrafusal muscle fibers. If the muscle spindle becomes slack, it goes "off the air" and no longer reports the length of the muscle. (b) Activation of gamma motor neurons contracts the poles of the spindle, keeping it "on the air."**

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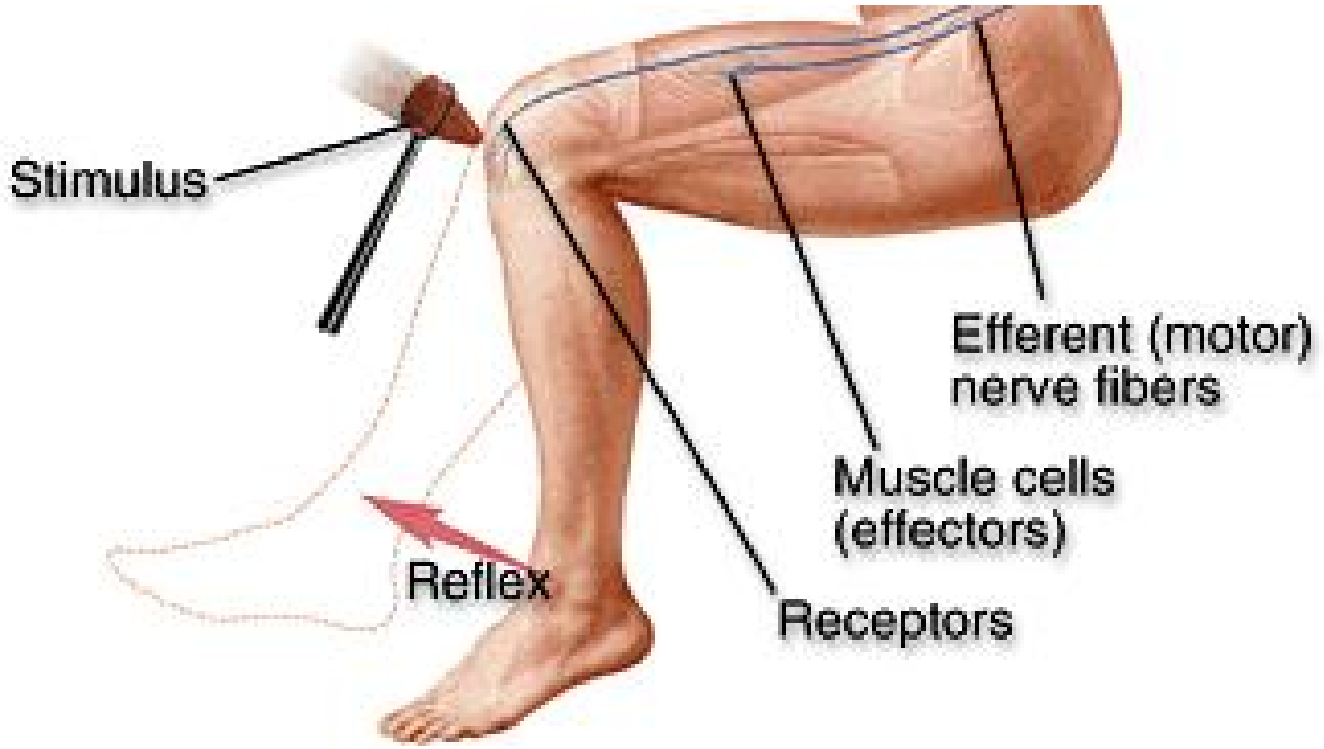
# Stretch Reflex

- **Stretch (myotatic) reflex-** When a muscle is stretched, it “fights back”- it contracts, maintains increased tonus, and feels stiffer than when unstretched.
- often feeds back to a set of synergists and antagonist muscles thereby
  - stabilizing joints by balancing the tension of the extensors and flexors
  - dampen (smooth) muscle action
- **reciprocal inhibition-** prevents muscles from working against each other by inhibiting antagonist

# Stretch Reflex

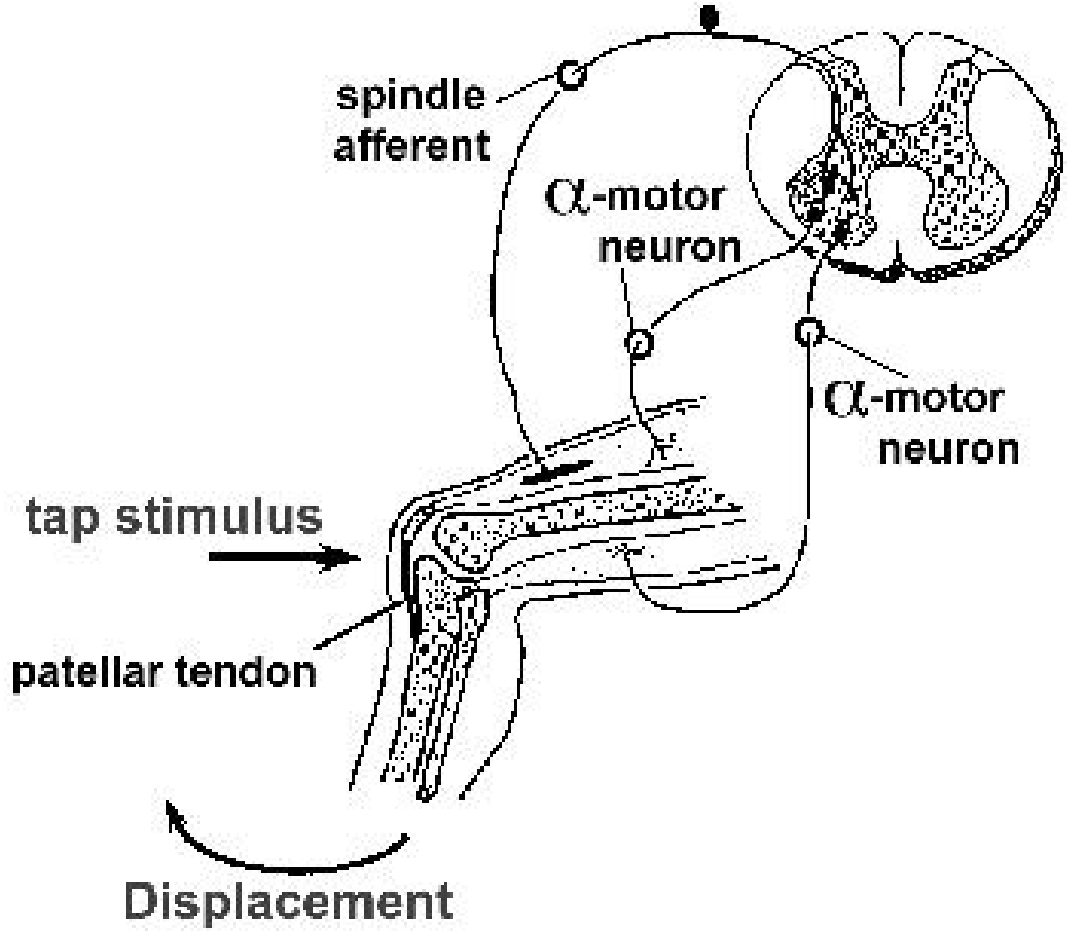
- stretch reflex is mediated primarily by the brain, therefore, is not strictly a spinal reflex
- a weak component of the spinal reflex is spinal and occurs even if the spinal cord is severed from the brain.
- the spinal component can be more pronounced if a muscle is stretched very suddenly and is the bases of the **tendon reflex**
  - ex. knee-jerk (patellar) reflex

# Patellar Reflex



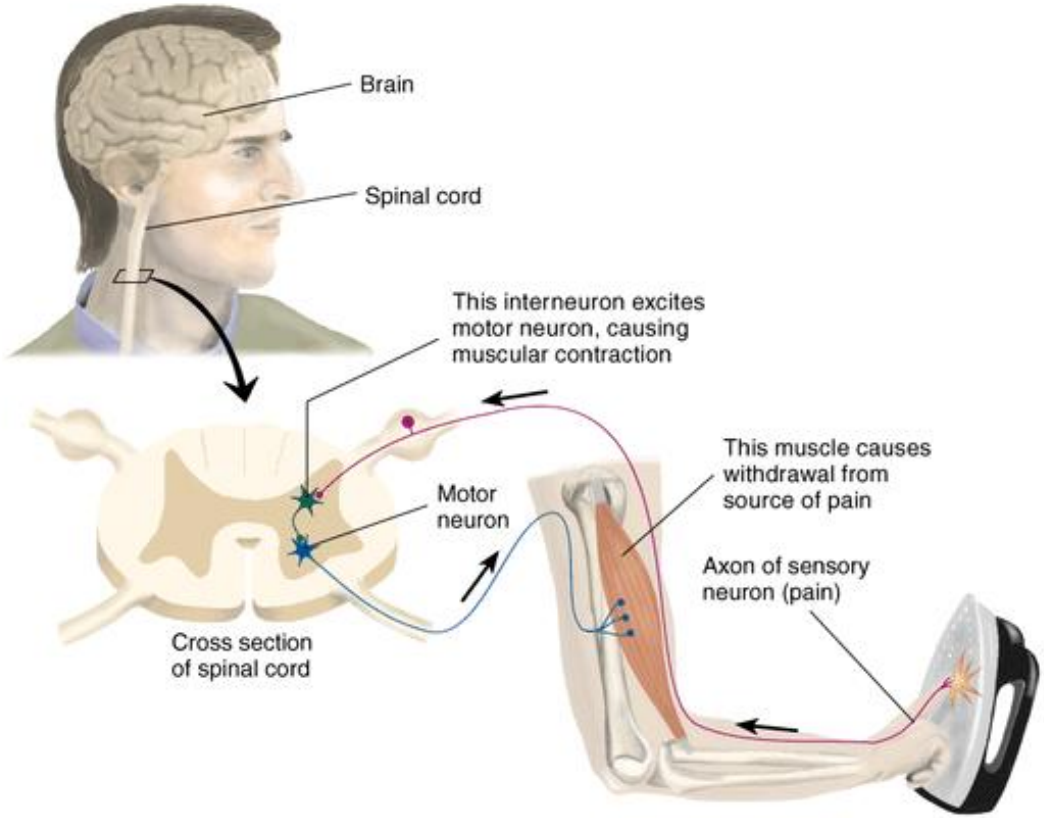

- tapping the patellar ligament suddenly stretches the quadriceps femoris. This stimulates numerous muscle spindles in the quads and sends and intense volley of signals to the spinal cord.

# Stretch Reflex




- tendon reflex is a **monosynaptic reflex arc-** only one synapse between the afferent and efferent neuron, therefore there is little synaptic delay and very prompt response
- occurs in 50 milliseconds, too fast for brain to be involved

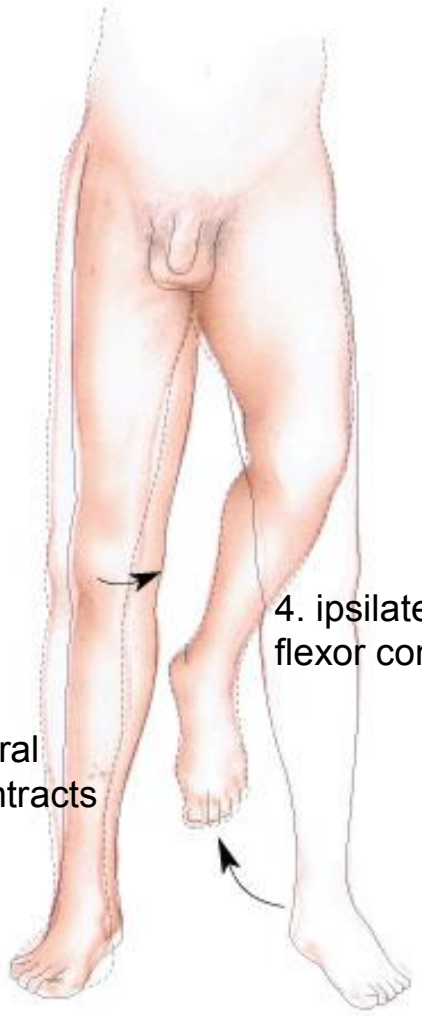
# Withdrawal Reflex

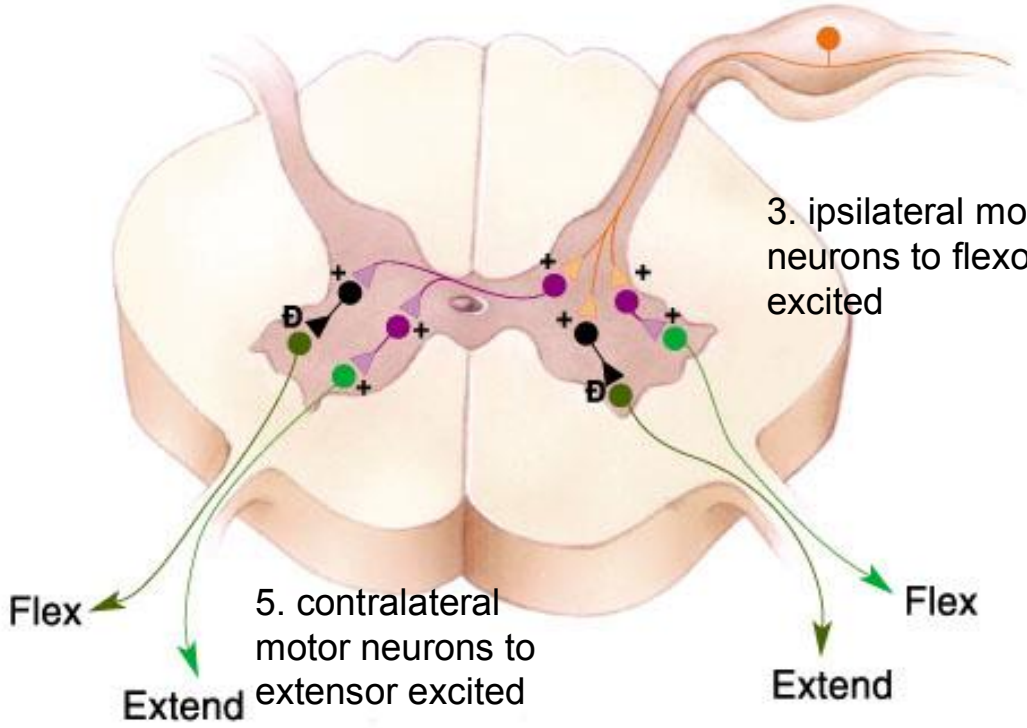

Brain
Spinal cord
This interneuron excites motor neuron, causing muscular contraction
This muscle causes withdrawal from source of pain
Motor neuron
Axon of sensory neuron (pain)
Cross section of spinal cord

- a more complex act involving a **polysynaptic reflex arc** with more synapses

# Flexor and Crossed Extensor Reflex

2. sensory neuron activates multiple interneurons






3. ipsilateral motor neurons to flexor excited

4. ipsilateral flexor contracts

5. contralateral motor neurons to extensor excited

6. contralateral extensor contracts

1. stepping on glass stimulates pain receptors in left foot

- **Golgi tendon organ** - stretch receptors **located within the tendons**, detecting the amount of stretch exerted by the muscles on the bones to which they are attached; encode degree of stretch by the rate of firing; **don't respond to length, but to how hard it is pulling**
- synapse onto an interneuron in the spinal cord gray matter which then synapse **onto the relevant alpha motor neuron, producing inhibitory (glycine) potentials**
  - decreases muscular contraction, prevents injury